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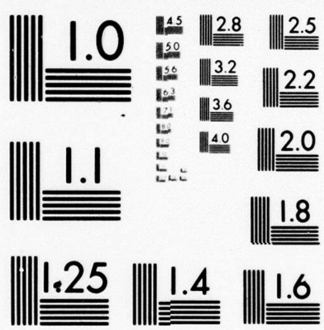

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TECHNICAL REPORT EL-79-4

FISHERIES AND LIMNOLOGICAL STUDIES ON WEST POINT RESERVOIR, ALABAMA-GEORGIA

by

W. D. Davies, W. L. Shelton, D. R. Bayne, J. M. Lawrence

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West Point Reservoir on the Chattahoochee River was impounded by a Corps of Engineers dam located 3.2 miles north of West Point, Georgia. Fishery and limnological studies funded by the Corps began in February 1976 to (a) document changes in the physical, chemical, and biological characteristics of West Point Reservoir over a period of years with emphasis on detection of those factors contributing to the expected decline in sport fishing success, and cont'

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20. ABSTRACT (Continued).

(b) implement and evaluate fishery management practices aimed at improving the catch per unit of effort of sport fisherman.

The lake waters were very soft and maintained a pH near 7.0. Water inflow provided a hydraulic retention time varying from 30 to 83 days. There was adequate nutrient loading to produce eutrophic conditions though the availability of carbon is believed to be a factor limiting the eutrophic potential of this lake.

Estimated mean phytoplankton densities varied from a low of 100 organisms/ml to a high of 26,000 organisms/ml. Mean zooplankton densities ranged from 1.4 organisms/l to 1,386 organisms/l.

Water quality and biological data gathered during this study indicated that West Point was a mesoeutrophic lake that produced sufficient fish foods to support a relatively high fish biomass (350 kg/ha).

An interpretation of water quality data as it relates to sport fish production indicated that West Point Lake maintained favorable environmental conditions to sustain aquatic life during the course of the study (Jan. 1976-Sept. 1977). Although the lake did chemically stratify during warm weather, adequate to optimum conditions always existed in the upper 4-m layer of water to support aquatic life.

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Summary

West Point Reservoir (25,864a) on the Chattahoochee River reached full pool in Spring 1975. Fishery and limnological studies funded by the U. S. Army Corps of Engineers began in February 1976 as a continuation of preimpoundment and early postimpoundment studies funded by the Fish and Wildlife Service, Auburn University, and the Bass Research Foundation.

An interpretation of water quality data as it relates to sport fish production indicated that West Point Lake maintained favorable environmental conditions to sustain aquatic life during the course of this study (Jan. 1976-Sept. 1977). Although the lake did chemically stratify during warm weather (June to October), adequate to optimum conditions always existed in the upper 4-m layer of water to support aquatic life. The lake waters were very soft (<20 mg/l $CaCO_3$ hardness) and maintained a pH near 7.0. Water inflow into the lake provided a hydraulic retention time varying from 30 to 83 days. Periods of greatest inflows occurred during winter and spring. During these periods turbidity produced by colloidal particles was often excessive and created extensive turbid conditions throughout the lake. Such turbid conditions interfered with light penetration into the water during these periods. Laboratory data indicated as much as 70 percent of the inflowing soil particle load was accumulated in the lake. These inflowing waters also transported 1.2 million kg of P into the lake and some 47 percent of this P was accumulated in the lake before these waters were released downstream at the dam. Adequate N to maintain an N:P ratio of 10:1 was also transported into the lake by inflowing waters. This was more than adequate nutrient loading to produce eutrophic conditions. The total carbon (inorganic plus organic) concentration was maintained at a low level (usually < 10 mg/l) throughout the study period. This meager loading of carbon is believed to be one factor limiting the eutrophic potential of this lake.

Estimated mean phytoplankton densities varied from a low of 100 organisms/ml at Station A in March 1975 to a high of 26,000 organisms/ml at Station B in July 1977. Mean chlorophyll a concentrations varied from 1.2 mg/m^3 at Station A in April 1977 to 40 mg/m^3 at Station D in March 1977 and at Station B in July 1977. Stations B and C supported significantly higher mean densities of phytoplankters than other mainstream stations, but Station D produced higher mean chlorophyll a standing crops (110 mg/m^2) during the course of the study. Yellowjacket Creek produced significantly higher phytoplankton densities and chlorophyll a standing crops than Wehadkee Creek.

Yellow-green algae (Division Chrysophyta) were dominant on most sampling dates. *Melosira granulata*, *M. varians*, *Cyclotella* spp. and various pennate diatoms were common constituents of the phytoplankters belonging to this group. Green algae (Division Chlorophyta) were dominant on occasions and consisted of *Ankistrodesmus convolutus*, *Scenedesmus quadricauda*, and other species of *Scenedesmus*. Blue-green algae (Division Cyanophyta) were dominant only at Station B in July 1977 when *Merismopedia* sp. was found in large numbers.

Quarterly estimates of mean net primary productivity of West Point Lake ranged from a low of 267 $mgC/m^2/day$ in March 1977 to a high of 1,798 $mgC/m^2/day$ in September 1977. Highest productivities were measured at Station B and lowest at Station A. Estimated annual mean productivity based on all measurements in 1976-77 was 689 $mgC/m^2/day$.

Organic matter content of suspended materials varied from 2.480 to 26.280 mg/l in West Point Lake waters during 1976-77. During this same period particulate carbon concentrations ranged from 0.03 to 8.06 mgC/l.

Total carbon concentrations ranged from 5.00 to 16.30 mgC/l and total organic carbon concentrations from 3.50 to 14.22 mgC/l in lake water during 1976-77. These values are low in comparison with similar reservoirs in the area.

Mean zooplankton densities ranged from 1.4 organisms/l at Station B in February 1977 to 1,386 organisms/l at Station D in April 1977. Stations C and D on the mainstream of the lake and Yellowjacket (G) and Wehadkee (F) Creeks supported similar standing crops that were higher than those encountered at other sampling stations. Dominant rotifers were Hexarthra sp., Synchaeta spp., Keratella cochlearis, and Polyarthra spp. Dominant cladocerans were Bosmina longirostris, Bosminopsis deitersi, and Chydorus sphaericus. Cyclops spp. and Diaptomus spp. were dominant copepods. Fewer organisms and less diverse zooplankton communities were found when water temperatures were 20°C or less. The riverine sampling station (A) produced fewer organisms and taxa than the more lentic areas.

Water quality and biological data gathered during this study indicate that West Point was a mesoeutrophic lake that produced sufficient fish foods to support a relatively high fish biomass (350 kg/ha).

Preimpoundment fishery studies revealed the presence of 53 species representing 14 families. Three Apalachicola drainage endemic species were collected in the study area; these species are not considered endangered or threatened.

Preimpoundment fish standing stocks were typical when compared with other southeastern streams. Based on this information, stocking was not considered necessary for fishes of sport interest; however, the introduction of threadfin shad was suggested.

Eleven species of fish present during preimpoundment have not been collected during postimpoundment studies. An additional five species disappeared during the first year of impoundment. A total of 37 species have maintained populations 2 years after impoundment. Six additional species have been collected since impoundment.

The 1975 year class of largemouth bass was extremely abundant resulting in a high level of recruitment to the population. Large numbers of fish competed for available prey. A shortage of small size prey resulted in a growth differential within the year class. Only the faster growing fish were recruited into the fishery the following spring.

Growth and recruitment to the population of 1976 and 1977 year classes of largemouth bass were considerably lower than that of the 1975 year class. As a result the 1975 year class supported the fishery through July 1977 when the 1976 year class reached harvestable size.

The harvest of largemouth bass (3.9 lb/a) during July 1976 through June 1977 must represent a high rate of exploitation as judged by the rate of tag returns (30%). The result was not "overfishing" in the classical sense; however, exploitation has altered the size composition so that the majority of the fish harvested are small.

Other species were also characterized by a dominant 1975 year class and demonstrated slow growth and recruitment into the fishery. For example, only a relatively small portion of the 1975 black crappie year class had entered the fishery by early 1977. Also, important forage fish populations exhibited slow growth and limited recruitment. Gizzard shad, for example, spawned in 1975 had only reached a modal length of 6 in. in August 1977.

Catch per fisherman hour for bass, crappie, and bream was 0.11, 0.12, and 0.13 lb., respectively. A total effort of approximately 70 fisherman hours per acre for the 18-month period represents moderate to heavy use of the fishery resources.

Increased sampling efficiency was indicated by analyzing the electro-fishing and creel data. Electrofishing was reduced from 108 to 72 samples/year without compromising accuracy and precision of estimates. Creel sampling was

stratified to the extent that 90% of the effort was concentrated during peak fishing. It was also determined that total sampling effort could be reduced by 33% without affecting the precision of estimates.

Preface

This report presents the results of the fisheries and limnological studies on the newly impounded West Point Reservoir, Georgia-Alabama, from February 1976 through November 1977. The investigation was conducted under Contract No. DACW39-76-C-0126 between the Department of Fisheries and Allied Aquacultures, Auburn University, Auburn, Alabama, and the U. S. Army Engineer Waterways Experiment Station (WES). In addition, preimpoundment and early postimpoundment studies funded by the U. S. Fish and Wildlife Service, Auburn University, and the Bass Research Foundation are included for completeness.

The report was written by W. D. Davies and W. L. Shelton (fisheries), D. R. Bayne (limnology), and J. M. Lawrence (water chemistry). The following individuals are acknowledged for their assistance in the study: D. Alston, F. Campbell, T. Campbell, O. Dakin, T. Forester, T. King, B. McCulley, M. Pierson, S. Malvestuto, S. Pullen, W. Seesock, K. Snowden, T. Timmons, and J. Turner.

This report was sponsored by the U. S. Army Engineer District, Mobile, and the Office, Chief of Engineers, U. S. Army; the contract was managed by the Environmental Laboratory, WES, of which Dr. John Harrison is Chief.

COL Drake Wilson, CE, and COL C. L. Blalock, CE, were District Engineers of Mobile and COL G. H. Hilt, CE, and COL J. L. Cannon, CE, were Directors of WES during the conduct of this study and preparation of this report. Technical Director of WES was Mr. F. R. Brown.

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Conversion Factors, U. S. Customary to Metric (SI)
Units of Measurement

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
acres	4046.856	square metres
cubic feet per second	0.02831685	cubic metres per second
Fahrenheit degrees	5/9	Celsius degrees or Kelvin*
feet	0.3048	metres
feet per second	0.3048	metres per second
inches	25.4	millimetres
miles per hour (U. S. statute)	1.609344	kilometres per hour
miles (U. S. statute)	1.609344	kilometres
pounds (mass)	0.4535924	kilograms
pounds (mass) per acre	0.000112	kilograms per square metres
square miles	2.589988	square kilometres

* To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: $C = (5/9)(F - 32)$. To obtain Kelvin (K) readings, use: $K = (5/9)(F - 32) + 273.15$.

FISHERIES AND LIMNOLOGICAL STUDIES ON WEST POINT RESERVOIR, ALABAMA-GEORGIA

Introduction

1. The West Point Reservoir on the Chattahoochee River was impounded by a Corps of Engineers dam located 3.2 miles (5.15 km) north of West Point, Georgia, at Chattahoochee River mile 201. The reservoir has a total drainage area of 3,380 square miles (8,754 km^2) and a surface area of 25,864 acres (10,467 ha) at the normal pool elevation of 635 feet (194 m) above mean sea level (msl) (U.S. Army Engineers 1963).

2. The Chattahoochee River originates in the Blue Ridge Mountains of north Georgia and flows southwesterly through the Piedmont province to West Point. Metamorphic and igneous rock form the substrata of the Piedmont, and the waters of this area are generally soft and low in mineral content (Whitlatch 1964). The runoff from the upper third of the drainage area is controlled by Lake Sidney Lanier. Some 30 miles[1] downstream from Lake Lanier and 70 miles upstream from West Point Lake, the Chattahoochee River receives the treated domestic and industrial effluents from over 50 percent of metropolitan Atlanta. Throughout the basin there is a rather high rate of soil erosion which is largely the result of careless construction practices.

3. When the lake was in the planning stage, the water quality in the Chattahoochee River below Atlanta was in a degraded condition. Thus, much concern was expressed about the excessive organic, nutrient, and pathogenic organism loading that would enter West Point Lake. In the interim between planning and the existence of this impoundment an extensive waste treatment program was implemented in this region of Georgia. Organic and pathogenic organism loadings

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[1] A table of factors for converting U.S. customary units of measurement not converted in the text can be found on page 15.

were greatly reduced, but nutrient loading is still a factor to be considered in operating this lake.

4. The area that was inundated to form West Point Lake was cleared of trees, stumps, and debris between elevation 600 and 637 feet msl. Trees below the 600-foot level were topped at elevation 619 feet msl as the lake was filled.

5. West Point Lake started filling in the fall of 1974, and by mid-November it had reached an elevation of approximately 617 feet msl. The lake was held at this level for approximately 5 months while the topping operation on some 3,800 acres of standing timber was completed.

6. Full power pool elevation of 635 feet msl was attained in early June 1975. Normal operations were to maintain this water level until November and then lower to the winter pool of 625 feet msl. The lake remains at this lower level until May and is then allowed to fill back to the summer pool elevation of 635 feel msl. Additional discussion of the reservoir and watershed is found in the West Point Fish Management Plan (U.S. Army Engineers 1975) and the Environmental Impact Statement (U.S. Army Engineers 1977).

7. The reservoirs of the southeastern United States provide abundant recreational opportunities. In this respect newly impounded reservoirs provide exceptional fishing, especially for carnivorous species such as the largemouth bass and crappie. However, within a few years catch per unit of effort reportedly declined (Bennett 1970). Jenkins and Morais (1971) analyzed data from reservoirs and found that the age of an impoundment, area, and growing season were the most significant factors of 10 environmental variables tested that correlated with angler harvest. Chance et al. (1975) discussed the decline in bass harvest over a 7-year period in the first decade of Norris Reservoir. The explanation for this boom-and-bust sequence is not fully understood; however,

numerous contributing factors have been suggested (Cahn 1937, Eschmeyer and Tarzwell 1941, Tarzwell 1942, Kimsey 1958, Stroud 1968, Poddubny 1971). The filling of a new reservoir presents a vast new area of unoccupied space. Inundated trees and stumps provide many new areas of cover, and flooding of rich bottom land contributes to the fertility of the body of water. The conditions are suited for rapid population expansion into the increased living space, new niches, and an abundance of food. For example, large numbers of bass are usually hatched and recruited in a newly impounded reservoir. At this time a large percentage of the forage is of a size that can be readily eaten by yearling bass. As a result, growth and survival are excellent. Eventually as a greater percentage of the fish biomass is composed of adult fish, reproduction of both bass and forage fish is suppressed which is later reflected in a decline in catch per unit of effort. Prolonged leaching of nutrients from bottom soils has decreased fertility of the water and reduced primary production within the ecosystem, which ultimately affects standing crop of sport fishes. Because of the scarcity of reliable observations on the dynamics of expanding reservoir fish populations and relationships between nutrient levels and fish food organism production, no effective management plan has emerged to circumvent the decline in fishing success.

8. The impounding of the Chattahoochee River to form the West Point Reservoir offers an excellent opportunity to document the changes that take place in expanding fish populations. These data can readily be related to the biological and chemical information available from existing preimpoundment surveys (Chookajorn 1973, Hiranvat 1973, Shelton 1974, Lawrence 1975). Aquatic studies for the Chattahoochee River have been conducted by Auburn University personnel since the mid-sixties (Bayne 1967, Rawson 1969, Gilbert 1969,

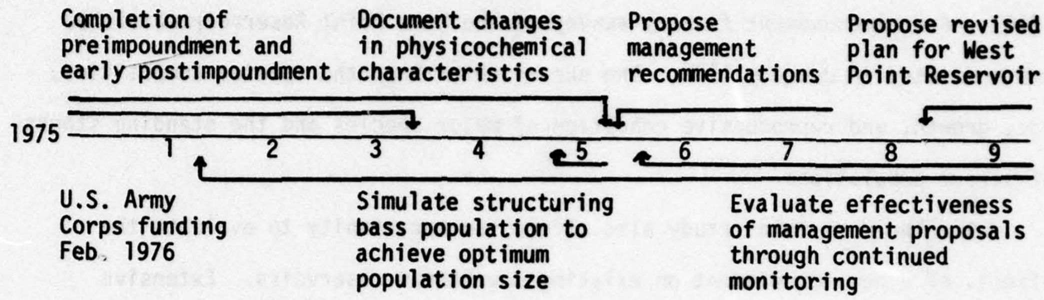
Lawrence 1971, Morris 1972, Keller 1973, Lawrence 1974, Davies and Shelton 1976). A preimpoundment fishery survey of the West Point Reservoir watershed was initiated in January 1972. The survey determined the species composition, age, growth, and reproductive condition of major species and the standing stocks of stream populations.

9. The West Point study also affords an opportunity to evaluate the effects of a new impoundment on existing downstream reservoirs. Extensive physicochemical studies and limited biological investigations have been conducted on both Bartlett's Ferry and Walter F. George Reservoirs (op. cit.). Reduction of nutrients entering the Chattahoochee River due to improved sewage treatment facilities in Atlanta, Georgia, and other municipalities discharging into the system coupled with the new impoundment at West Point may seriously affect productivity of downstream impoundments. Carbon and phosphorus have been identified as factors limiting production in Bartlett's Ferry and Walter F. George Reservoirs, respectively (Lawrence 1971, Water Resources Engineers 1975).

10. West Point Reservoir is receiving substantial fishing and other recreational pressure due to its proximity to population centers such as Atlanta and LaGrange, Georgia. West Point Reservoir can be used as a model of recreational management in which fishing is an integral and major component.

11. Study objectives include 1) documenting changes in the physical, chemical, and biological characteristics of West Point Reservoir over a period of years with emphasis on detection of those factors contributing to the expected decline in sport fishing success, and 2) implementing and evaluating fishery management practices aimed at improving the catch per unit of effort of sport fishermen.

12. The following schedule illustrates the expected sequence of events:



Methods and Design

Water Quality Studies

13. Locations of sampling stations and depths on West Point Lake appear in Table 1 and Figures 1 and 2.

Table 1

Sampling locations and depths on West Point Lake, 1974-1977

	Location	Depth sampled, m
Sta. A	Chattahoochee River, Franklin, GA	0, 2
Sta. B	GA. Hwy 219 Bridge	0, 2, 4, 8, 12
Sta. C	GA. Hwy 701A Bridge	0, 2, 4, 8, 16
Sta. D	300 m above West Point Dam	0, 2, 4, 8, 16, 24
Sta. E	300 m below West Point Dam	0
Sta. F	Wehadkee Cr. above AL. Hwy 701 Bridge	0, 2, 4
Sta. G	Yellowjacket Cr. above AL. Hwy 701 Bridge	0, 2, 4

14. Water samples were collected on 23 dates between November 1974 and July 1977 as indicated in Table 2. All water samples for chemical analyses were collected with a submersible, plastic water pump and hose apparatus, stored in Nalgene plastic containers, cooled, and returned directly to the laboratory at Auburn University, Auburn, Alabama. The analytical procedures used for water quality determinations are presented in Table 3. All measurements of temperature, dissolved oxygen concentration, and light penetration were obtained in situ at each station on each sampling date.

Water Quality Data Processing

15. To facilitate handling the vast amount of data generated by this study, the time span between October 1974 and September 1977 was divided into

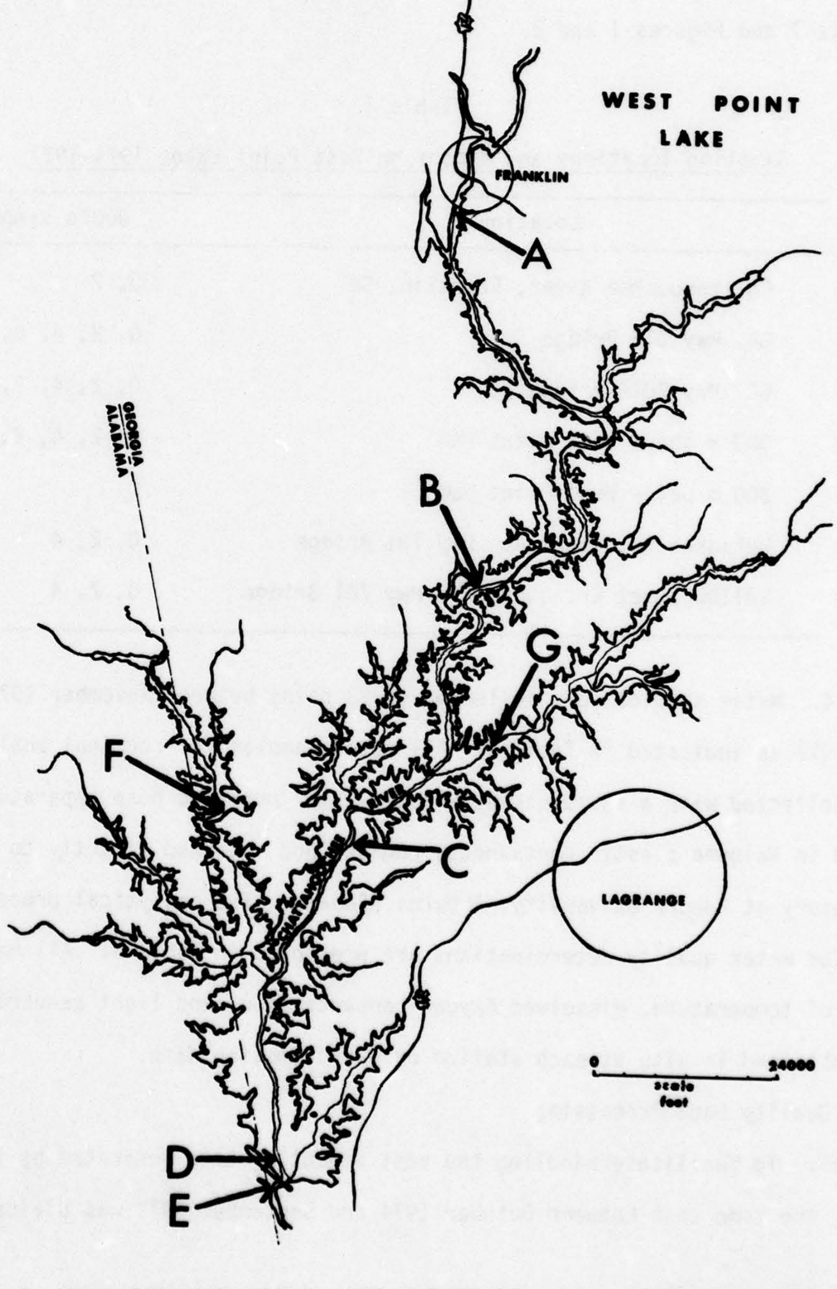


Figure 1. Map of West Point Lake with indicated locations of sampling stations.

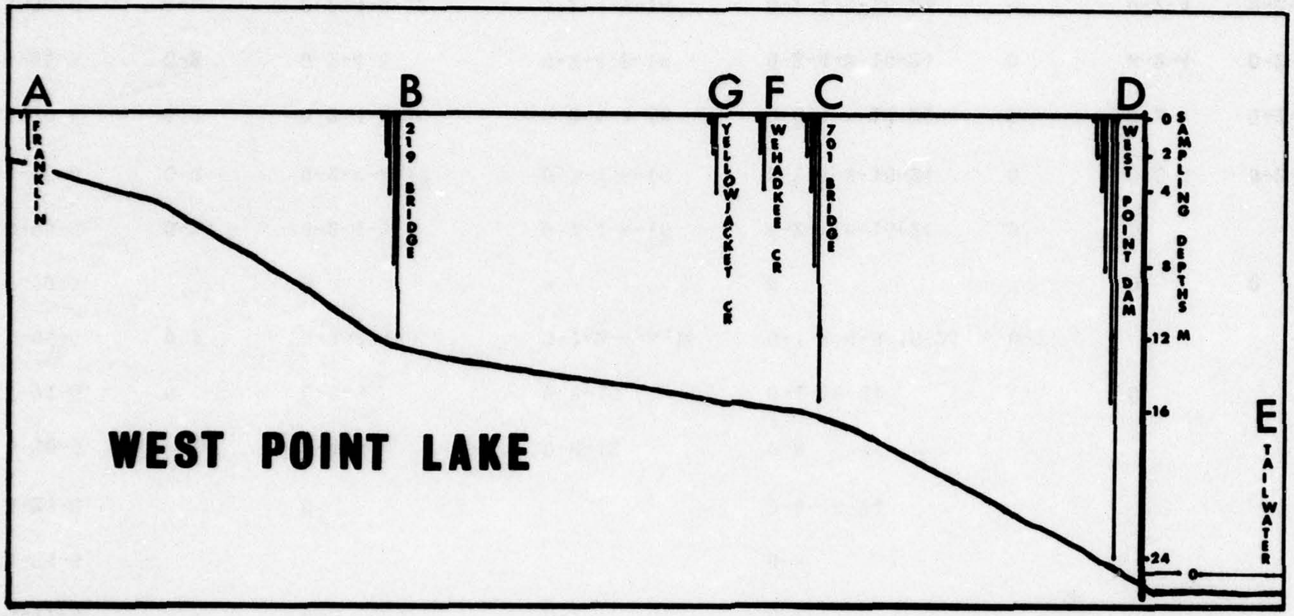


Figure 2. Diagram of sampling depth profiles at each station on West Point Lake.

Table 2

Dates, stations and depths from which water quality samples were taken from West Point Lake, 1974-1977.

	Stations and depths sampled, m						
Date	A	B	C	D	E	F	G
11-14-4				0-2-8			
3-12-5		0-2	0-2	0-2			
5-24-5				0-8			
5-26-5		0		0-8-16-24			
6-20-5		0-4	0-6-12	0-8			
7-01-5	0	0-4-8	0-8-16	0-4-16-24		0	
8-05-5	0-1	0-1-2-4-8	0-1-2-4-8-16	0-1-2-4-8-16-24	0-1		
8-19-5		0	0	0		0	0
9-09-5	0-2	0-2-4-8	0-2-4-8-16	0-2-4-8-16-24	0		
11-06-5	0-2	0-2-4-8-12	0-2-4-8-16	0-2-4-8-16-24	0	0-2-4	0-2-4
1-30-6	0-2	0-2-4-8-10	0-2-4-8-16	0-2-4-8-16-24	0	0-2-4	0-2-4
4-05-6	0-2	0-2-4-8	0-2-4-8-16	0-2-4-8-16-24	0	0-2-4	0-2-4
5-04-6	0-2	0-2-4-8-12	0-2-4-8-16	0-2-4-8-16-24	0	0-2-4	0-2-4
6-09-6	0-2	0-2-4-8-12	0-2-4-8-16	0-2-4-8-16-24	0	0-2-4	0-2-4

(Continued)

Table 2 (Concluded)

	Stations and depths sampled, m						
Date	A	B	C	D	E	F	G
8-02-6	0-2	0-2-4-8-12	0-2-4-8-16	0-2-4-8-16-24	0	0-2-4	0-2-4
9-09-6	0-2	0-2-4-8-10	0-2-4-8-16	0-2-4-8-16-24	0	0-2-4	0-2-4
11-03-6	0-2	0-2-4-8-12	0-2-4-8-16	0-2-4-8-16-24	0	0-2-4	0-2-4
12-14-6	0-2	0-2-4-8	0-2-4-8-16	0-2-4-8-16-24	0	0-2-4	0-2-4
2-02-7	0-2	0-2-4-8-12	0-2-4-8-16	0-2-4-8-16-24	0	0-2-4	0-2-4
3-16-7	0-2	0-2-4-8	0-2-4-8-16	0-2-4-8-16-24	0	0-2-4	0-2-4
4-27-7	0-2	0-2-4-8	0-2-4-8-16	0-2-4-8-16-24	0	0-2-4	0-2-4
6-09-7	0-2	0-2-4-8-12	0-2-4-8-16	0-2-4-8-16-24	0	0-2-4	0-2-4
7-27-7	0-2	0-2-4-8-12	0-2-4-8-16	0-2-4-8-16-24	0	0-2-4	0-2-4

Table 3

Analytical methods for determination of water quality.

Parameter	Method	Reference	Max holding before analyses
Temperature	Thermistor	EPA Manual 1974, p- 286	0
pH	Glass electrode	EPA Manual 1974, p- 239	6 hrs
Turbidity	Turbidimeter	EPA Manual 1974, p- 295	24 hrs
Light penetration	Submersible photo cell		0
	Secchi disk	Welch 1948, p-159	0
Specific conductance	Wheatstone bridge	EPA Manual 1974, p- 275	24 hrs
Dissolved oxygen	Electrode	EPA Manual 1974, p- 56	0
Free carbon dioxide	Titrametric	Standard Methods, p- 92	6 hrs
Alkalinity	Electrometric	Standard Methods, p- 52	24 hrs
	Titration		24 hrs
Chlorides	Selective ion electrode		24 hrs
Sulfates	Turbidimetric	EPA Manual 1974, p- 277	24 hrs
N as ammonia	Colorimetric	EPA Manual 1974, p- 159	24 hrs
N as nitrites	Colorimetric	EPA Manual 1974, p- 215	24 hrs
N as nitrates	Cadmium reduction	EPA Manual 1974, p- 201	24 hrs
	Selective ion electrode		
P, orthophosphate	Colorimetric	EPA Manual 1974, p- 249	24 hrs
Iron	Atomic absorption	EPA Manual 1974, p- 110	24 hrs
Manganese	Atomic absorption	EPA Manual 1974, p- 116	24 hrs

National Environmental Research Center, 1974. Methods for chemical analysis of water and wastes. U.S. Environmental Protection Agency. Washington, D. C. 298 pp.

American Public Health Association. 1971. Standard methods for the examination of water and wastewater. 13th ed. New York. 874 pp.

Welch, P. S. 1948. Limnological methods. McGraw-Hill Book Co., Inc. New York. 381 pp.

3-month intervals (1st quarter = October 1-December 31, 1974; 12th quarter = July 1-September 30, 1977). For each of these quarters a mean was obtained for each measured physical or chemical water quality parameter for each depth at each station. Water samples obtained prior to January 1, 1976, were not collected in duplicate, whereas samples collected after this date were all duplicated. Parameter means are presented in the Appendix as a table for nonduplicated values and as a table in the text for duplicated values.

16. A modified split-plot analysis of variance was run on data (from January 1976 through September 1977) for each parameter. Data for each parameter processed by these analyses were divided into the following groups:

Group 1. All 0- and 2-m data for Stations A, B, C, D, F, and G.

Group 2. All 0-, 2-, and 4-m data for Stations B, C, D, F, and G.

Group 3. Data for all depths at Stations B, C, and D.

17. This stratification of data was selected in an attempt to minimize the confounding that was inherent in the design of this study. Unfortunately, no analyses of these data yielded much information beyond that which is obvious when one examines the quarterly means of each parameter for each depth at each station. Analysis of variance tables for each parameter tested are given in the Appendix.

18. The data on replication of the various water quality parameters were analyzed by a linear analysis of variance model and the results for each parameter were not significant at $P = 0.05$. This indicates that continued duplicate sampling of water and analyzing for the various parameters in the laboratory is not providing any meaningful information in this study of water quality.

Limnological Studies

19. Plankton. Plankton sampling stations were the same as those reported for water quality sampling, Figure 1. During 1975, prior to the initiation of this study, plankton samples were collected at various locations and depths as indicated in Table 4. Replicate samples were not collected during this period. During 1976 and 1977 triplicate zooplankton and phytoplankton samples were collected quarterly at each depth at all stations as indicated in Table 5.

20. A submersible, plastic water pump and hose apparatus was used to collect water at all depths. The phytoplankton sample consisted of 500 ml of water measured into a flat-bottomed, 1-liter, Nalgene jar containing a merthiolate preservative. These samples were transported to the laboratory, allowed to settle at least 24 hours, and concentrated by siphoning before being analyzed (Table 6). For purposes of enumeration, organisms were counted and reported by taxonomic group. Dominant organisms were identified to species when possible (Prescott 1970, Whitford and Schumacher 1973, Cocke 1967, Weber 1971, Smith 1950).

21. Zooplankton samples were collected by passing 40 liters of water through an 80-μ mesh Wisconsin-style plankton net. Captured organisms were washed into a 100-ml Nalgene container, preserved with formalin, and transferred to the laboratory for analysis (Table 6). Zooplankters were identified to species when possible (Edmondson 1959, Pennak 1953).

22. Primary Production. The carbon-14 method of estimating phytoplankton production was used in 1976 and 1977 (Table 6). Duplicate light and dark bottles were incubated for 3 hours at each of three depths within the photic zone at Stations A, B, and D (Figure 1). The lower limit of the photic zone was defined by multiplying the Secchi disc visibility by a factor of four (Taylor

Table 4

Plankton sampling dates, stations, and depths in 1975.

Date	Station	Depth (m)
12 March	B, C, D	0
24 May	B	0, 8
	C	0
2 July	A, B, C	0, 4
	F	0
5 August	A	0, 1
	B	0, 1, 2, 4
	C	0, 2, 4, 8
6 November	A	0, 2
	B, C, F, G	0, 2, 4
	D	0, 2, 4, 8
	E	0

Table 5

Plankton and chlorophyll sampling stations and depths on West Point Lake, 1976-1977.

Location	Station number	Station description	Depth (m)
Main stem	A	Franklin, GA (Hwy U.S. 27)	0,2
	B	Hwy 219	0, 2, 4
	C	Hwy 701A	0, 2, 4
	D	Dam	0, 2, 4, 8
	E	Tailwater	0
Tributaries	F	Wehadkee Creek	0, 2
	B	Yellowjacket Creek	0, 2

Table 6

Primary productivity and related variables.

Variables	Method	Reference
Primary productivity	C_{14} method	3
Phytoplankton	Counting Chamber (enumeration)	2
Zooplankton	Counting Chamber (enumeration)	2
Chlorophyll	Trichromatic method	2
Total carbon	Total organic carbon analyzer	3
Total organic carbon		
Suspended matter		
Dry weight*	Gravimetric	4
Organic weight*	Gravimetric	4
Carbon*	Carbon analyzer	4
Phosphorus**	Colorimetric	1
Macrophytes (Distribution and abundance)	Visual observation	2

*Collected on Gelman glass fiber filter.
**Collected on 0.45-μ millipore filter. Filter ashed 1 hr. 600°C, residue dissolved in 0.5 N HCl.

1. National Environmental Research Center. 1974. Methods for chemical analysis of water and wastes. U.S. Environmental Protection Agency. Washington, D.C. 298 pp.

2. Weber, C. I., ed. 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. U.S. Environmental Protection Agency. Washington, D.C.

3. American Public Health Association. 1971. Standard methods for the examination of water and wastewater. 13th Ed. Amer. Pub. Health Assoc. New York. 874 pp.

4. Lawrence, J. M. 1971. Dynamics of chemical and physical characteristics of water, bottom muds, and aquatic life in a large impoundment on a river. Final Report of OWRR Project, Auburn Univ. Agr. Exp. Sta. Auburn, AL. 183 pp.

1971a). Bottles were incubated at the lower limit of the photic zone, midway between the lower limit and the surface and just below the surface. The study was repeated for three consecutive days in June, September, and December 1976, and March, June, and September 1977. Productivity was calculated and reported as mg C/m^2/day. Mean productivity values for the three days were extrapolated to mean quarterly estimates based on total solar radiation measured during the quarter (Appendix Table 1).

23. Chlorophyll. At six-week intervals during 1976 and 1977, estimates of chlorophyll a, b, and c content were made on water samples taken at stations and depths indicated in Figure 1 and Table 5. Water samples were pumped into 1-liter Nalgene containers, cooled, and returned to the laboratory where the suspended matter was filtered onto 0.45-μ millipore filters. Standard analytical procedures were used to measure and calculate chlorophyll content (Table 6).

24. Carbon. Total carbon and total organic carbon were determined (Table 6) on those water samples collected for chemical analyses and described earlier.

25. Suspended Matter. Estimates of suspended matter dry weight, organic content, carbon, and phosphorus were made on all water samples collected for chemical analyses (Table 2). Reservoir waters were filtered through 0.45-μ millipore filters for phosphorus determinations and through Gelman A-E glass fiber filters for total suspended residue, total carbon, and organic matter determinations. Analytical procedures used for these determinations are given in Table 6.

26. Macrophytes. The distribution and estimated abundance of aquatic macrophytes were determined by visual observation (Table 6) of shoreline and shallow water areas during growing seasons of 1975-77.

Fishery Studies

27. Fish Population Characteristics. Preimpoundment fishery studies were accomplished prior to the present contract but will be discussed in this report; methods are outlined in Shelton (1974). The reservoir has been divided into three more or less equal areas (labeled 1, 2, and 3 on Figure 3). Each area has been further subdivided into three parts for electrofishing sampling and two parts for creel estimates. Sampling both the fish populations and harvest was initiated by first randomly selecting an area with each having a predetermined probability of being selected; the next area to be sampled was randomly selected from the remaining two. When all three areas were sampled, the selection procedure considered all three areas again.

28. Sampling for size and relative recruitment into the population involved electrofishing, seining, and experimental gill netting. Each week, three samples were taken in a major area, with one sample taken from each of the three subdivisions. One station was designated as a reference station. The other two samples within each division were chosen at random with the restriction that the shoreline be suitable for the gear being employed. Each sample consisted of "fishing" for a 45-min period a section of shoreline with an electroshocker (Davies and Shelton 1976). The size, number, and species composition of the catch was recorded. In addition, food habits, stage of sexual maturity for largemouth bass, and scale samples for growth determination were taken from fish collected by electrofishing. Seining and rotenone poisoning were used to adequately sample young-of-the-year. Fall and winter sampling also included gill and trap netting.

29. At least four cove rotenone samples (1-2 acres each) were conducted each year beginning in August 1975 using the general procedures outlined by

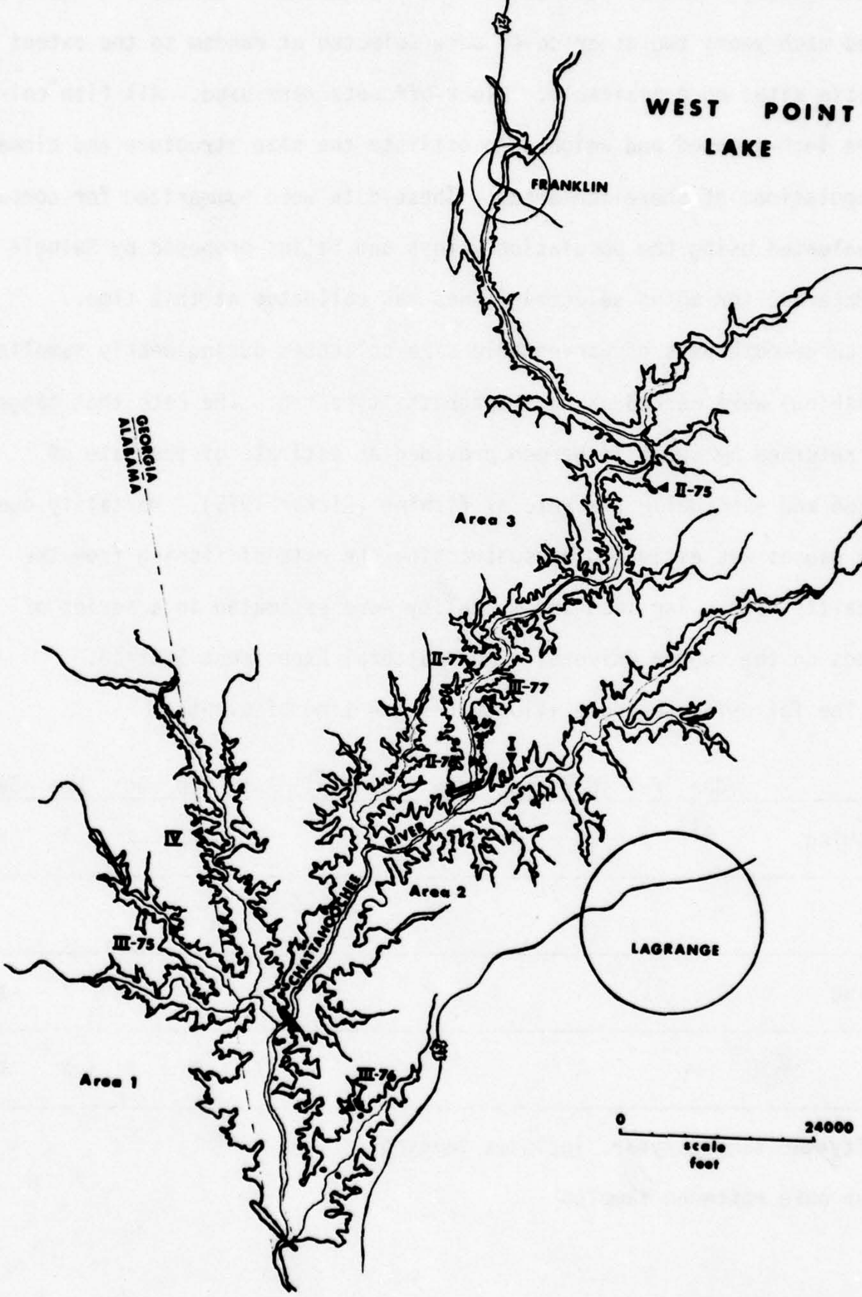


Figure 3. Fishery study areas and locations of control (I, IV) and selected (II, III) rotenone sample sites (▲).

Hayne et al. (1968). Two of the coves were designated as controls (Figure 3) and sampled each year; two other coves were selected at random to the extent that suitable sites were available. Block-off nets were used. All fish collected were inch-grouped and weighed to estimate the size structure and biomass of fish populations of shoreline areas. These data were summarized for comparison and evaluated using the population values and ratios proposed by Swingle (1950). Material for aging selected fishes was collected at this time.

30. Largemouth bass of harvestable size collected during weekly sampling (electrofishing) were marked using a spaghetti type tag. The rate that tagged fish were returned by sport fishermen provided an estimate of the rate of exploitation and eventually the rate of fishing (Ricker 1975). Mortality due to natural causes was estimated by subtracting the rate of fishing from the total mortality rate. Tag loss and mortality were estimated in a series of 0.25-a ponds on the Auburn University Agricultural Experiment Station.

31. The following schedule illustrates the time of events:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Electrofishing	X[1/]	X	X	X	X	X	X	X	X	X	X	X
Rotenone							X[2/]	X				
Gill netting								X	X	X	X	X
Trapping								X	X	X	X	X

[1/] Fifty-two samples/year, includes tagging

[2/] Four cove rotenone samples

32. Estimates of Harvest, Fishing Effort, Fishermen Profiles, and Effectiveness of Fishing Structures. The harvest, by size, species, and associated effort, was estimated from a statistically designed roving creel survey and supplemented with an access creel during one season (Davies and Shelton 1976). Fishing pressure on Alabama's public fishing lakes is distributed about equally on weekdays and weekends/holidays (Personal communication, B. W. Smith[1]). Sampling effort on West Point Reservoir was therefore equally distributed on weekdays and weekends until overflight data were available. Two overflights/month, one weekday and one weekend day, were made and the probabilities restructured. Seasonal variation in fishing effort is not as well defined, but appears to build up in April and remains at a high level through September. As a result, until a definite pattern emerged, sampling effort was equally allocated by months within the period April through September with 5 weekdays and 5 weekend days/holidays sampled each month; during the period October through March sampling effort averaged 3 days for each area. Each day was divided into three 4-hour periods. The selection of either the morning, midday, or afternoon period was weighted on a 0.167 (morning), 0.342 (midday), and 0.491 (afternoon) basis according to overflight information. After a 4-hour period was chosen, the creel clerk randomly chose whether he interviewed first or counted first, and what direction (left or right) he left the ramp. "Instantaneous" counts of fishermen were made and the catch per unit of effort determined from fishermen interviews. Since harvest rates were based on incomplete trips, business reply cards were distributed to provide data on completed trips. If the card was not returned, the estimated departure time was used to estimate

[1] Assistant Chief Fisheries, Alabama Department of Conservation, Montgomery, Alabama.

the length of trip. The harmonic mean was used to estimate average trip length. The fishing effort for each day was calculated as follows:

$$\text{Fishing effort} = \frac{\text{harmonic mean fishing time} \times \text{\# of fishermen}}{\text{sampling probability}}$$

33. For each month an estimate of fishing effort was derived. Total catch by species is the product of fishing effort and catch per unit of effort. Confidence limits for monthly estimates were computed as for any stratified random sample (Steel and Torrie 1960).

Water Quality

Results

34. Information on each physical or chemical water quality parameter for the entire study period (November 1974-September 1977) is presented in summary form in this section. Mean measurements on each parameter (other than temperature, dissolved oxygen (D.O.), and Secchi disc visibility) for each quarter are presented.

35. Temperature and D.O. concentrations at the various stations and depths for each sampling date are summarized in Table 7. Isopleths of each parameter for corresponding dates in each quarter of 1976 and 1977 are presented in Figures 4 and 5. The eight sets of isopleths illustrate the trends in water temperature and related D.O. concentrations for each quarter of the 21-month study period. During the colder months (December until March) the water temperature was relatively homogenous, with the temperature varying with the severity of the weather. During these same periods the D.O. concentrations were relatively uniform at or near saturation.

36. During early spring the water temperatures increased fairly rapidly and by the first of May surface waters were some 5° to 7° warmer than bottom waters. During these same periods D.O. concentration trends (Figures 4 and 5) indicated that chemical stratification was beginning to occur.

37. Summertime water temperatures ranged from 30+° on surface to 21° at a 24-m depth. Temperature patterns (Figures 4 and 5) during these periods were dependent upon weather conditions as well as upon the rate of discharge by West Point Dam. D.O. concentration isopleth patterns for each summer indicate the variability in stratification that may be anticipated during hot weather. The general trend for both summers indicated that inflowing waters might vary in

Table 7

Temperature (°C) and dissolved oxygen (DO, ppm) concentrations in West Point Lake waters at given depths (m) for each station on indicated sampling dates.

Station	Depth	6-20-75 °C	6-20-75 DO, ppm	7-1-75 °C	7-1-75 DO, ppm	8-5-75 °C	8-5-75 DO, ppm	9-9-75 °C	9-9-75 DO, ppm	11-6-75 °C	11-6-75 DO, ppm
A	0			27.0	6.0	28.0	5.2	27.5	6.5	19.0	8.0
	2					28.0	5.2	27.5	6.5	18.0	7.7
B	0	30.0	7.3	27.0	11.5	28.0	8.0	30.0	11.0	19.0	8.6
	2					27.5	6.7	27.5	[illegible].4	19.0	8.0
	4	28.0	4.3	26.3	8.3	26.5	4.6	24.0	5.2	18.3	7.3
	8			25.2	0.7	25.0	1.6	23.0	5.1	18.3	6.8
	12									18.0	6.5
C	0	28.0	10.5	27.0	9.3	27.0	10.0	30.0	8.0		
	2					27.0	8.8	28.5	6.4		
	4	25.0	0.6			27.0	8.2	28.0	3.2		
	8	22.0	0.2	25.0	0.3	26.0	1.5	26.0	1.4		
	16			22.0	0.2			25.0	1.3		
D	0	28.0	9.5	27.0	8.2	27.0	6.6	30.7	7.1	21.0	8.8
	2					27.0	6.4	29.0	6.5	20.5	7.8
	4			27.0	8.0	26.0	4.3	28.5	4.6	20.0	5.8
	8	26.0	5.5			26.0	3.4	27.0	1.2	19.5	4.7
	16			24.0	0.5	25.0	0.2	26.0	1.1	19.5	4.6
	24										
F	0			27.5	7.4					20.5	11.2
	2									20.5	11.1
	4										
G	0									20.5	9.3
	2									19.5	7.9
	4										
E	0					25.0	4.5	27.0	3.0	20.0	4.6

Table 7 (continued)

Station	Depth	1-20-76		4-8-76		5-5-76		6-9-76		8-2-76		9-8-76		11-3-76		12-14-76	
		°C	DO, ppm	°C	DO, ppm	°C	DO, ppm	°C	DO, ppm	°C	DO, ppm	°C	DO, ppm	°C	DO, ppm	°C	DO, ppm
A	0	9.0	11.6	15.0	9.5	19.0	7.2			26.5	6.0	27.5	5.8	14.5	7.1	11.0	9.4
	2	9.0	11.6	15.0	9.7	19.0	7.2			27.0	5.9	27.0	5.6	14.0	7.0	10.5	9.4
B	0	10.0	12.2	15.5	8.4	21.5	10.7			29.0	9.2	26.3	8.2	14.0	8.5	10.0	9.4
	2	9.5	12.4	15.3	8.2	19.0	8.5			28.7	6.2	26.0	7.0	13.5	8.1	10.0	9.3
	4	9.0	11.6	15.0	8.0	18.3	7.0			27.4	3.7	25.3	5.7	13.5	8.1	10.0	9.2
	6	9.0	11.6	15.0	8.0	17.5	6.0			26.0	2.7	24.3	3.7	13.5	8.1	8.5	9.4
	12	9.0	11.6			17.0	5.3			25.9	1.8	23.5	4.3	13.5	8.0		
C	0	10.0	11.6	17.6	7.8	19.5	11.7	28.4	11.7	28.0	7.3	25.5	6.8	17.0	8.5	8.5	9.4
	2	9.5	11.5	17.0	7.7	19.0	9.2	22.0	8.3	27.8	7.0	25.5	6.5	16.5	7.7	8.5	9.4
	4	9.0	11.0	16.5	7.6	18.0	9.0	21.5	6.8	26.0	2.2	25.3	6.1	16.5	7.5	8.5	9.4
	8	9.0	11.0	16.0	7.5	18.0	6.4	21.0	5.3	24.0	0.2	25.0	5.4	16.3	7.3	8.5	9.4
	16	9.0	11.0	16.0	7.0	16.5	5.6	19.5	4.3	22.0	0.1	24.5	0.2	16.3	7.2	9.8	9.0
D	0	10.0	12.0	17.5	10.3	19.5	9.4	25.4	9.1	27.5	7.3	27.0	6.7	19.0	8.2	10.0	9.0
	2	9.5	11.5	17.5	9.2	19.5	9.1	24.0	8.3	27.5	7.3	26.7	6.1	19.0	7.5	10.0	9.0
	4	9.0	11.5	17.0	9.0	19.5	9.0	23.6	7.3	27.5	7.3	26.3	6.0	18.5	7.2	10.0	9.0
	8	9.0	11.5	16.0	7.1	18.5	8.1	22.8	6.3	27.5	7.3	26.0	5.8	18.0	7.1	9.2	9.0
	16	9.0	9.0	15.0	5.5	16.0	2.2	20.4	1.8	23.0	6.4	26.0	1.3	18.0	7.1	9.2	9.0
	24					16.0	1.8	19.4	0.5	21.0	0.1	24.3	0.5	17.5	6.8	9.2	9.0
F	0	10.5	12.0	18.5	8.3	20.5	9.5	26.5	8.7	28.0	7.0	26.0	5.4	16.5	7.6	8.0	9.2
	2	10.0	11.6	18.0	7.9	20.0	7.0	22.0	4.4	28.0	6.8	26.0	4.7	16.0	7.1	8.0	8.6
	4	9.0	11.6	17.5	7.8	18.5	4.4	23.0	6.2	26.0	6.3	26.0	4.3	15.5	6.6	8.0	8.8
G	0	10.2	11.1	19.0	8.3	21.5	10.8			29.0	8.1	26.5	7.1	16.5	7.2	8.5	9.2
	2	10.0	11.0	18.0	7.8	19.5	9.5			29.0	8.2	26.0	6.1	15.5	7.1	8.0	9.0
	4	9.5	10.0	17.5	6.7	17.5	5.2			26.0	4.3	26.0	4.5	15.0	6.5	8.0	9.0
E	0	9.0	11.5	16.0	7.5	17.0	8.4	23.0	5.5	23.5	3.5	23.5	3.7	17.5	6.9	10.2	9.5

Table 7 (continued)

Station	Depth (m)	2-7-77 °C	2-7-77 DO, ppm	3-16-77 °C	3-16-77 DO, ppm	4-27-77 °C	4-27-77 DO, ppm	6-9-77 °C	6-9-77 DO, ppm	7-27-77 °C	7-27-77 DO, ppm	9-13-77 °C	9-13-77 DO, ppm
A	0	6.0	11.0	16.0	8.4	13.0	10.0			26.6	6.8	22.2	6.9
	2	6.0	10.9	15.0	8.4	13.0	10.0			26.6	6.8	22.2	6.8
B	0	5.4	10.8	16.5	8.2	18.0	10.4	26.5	7.8	28.5	10.4	27.0	11.0
	2	6.0	10.8	15.5	7.8	16.5	9.0	26.2	7.3	28.5	10.2	26.0	8.3
	4	6.0	10.5	16.0	7.8	16.0	8.7	25.1	4.6	27.0	6.6	25.2	5.9
	8	6.0	10.9	16.0	7.7	15.5	8.7	23.0	1.6	26.5	5.6	25.0	4.6
	12	5.5	11.0					21.2	0.8			23.0	4.0
C	0	5.4	11.8	16.5	8.6	19.5	9.2	26.6	7.6	31.0	5.2	29.0	6.8
	2	5.4	11.8	16.0	8.4	19.5	8.8	26.5	6.6	30.0	5.3	29.0	6.4
	4	5.4	11.8	16.0	8.0	19.0	8.8	26.4	6.4	30.3	5.2	28.5	5.3
	8	5.4	11.8	15.2	7.2	17.5	8.5	25.0	4.2	29.5	1.1	27.5	3.1
	16	5.4	12.8	14.5	7.0	16.5	8.0	20.0	3.2	26.0	0.8	25.5	1.5
D	0	8.5	12.0	16.0	9.0	20.0	9.4	28.0	6.8	30.5	6.8	28.0	5.6
	2	5.0	12.6	16.0	8.4	20.0	8.9	27.0	6.7	30.5	5.6	27.5	5.0
	4	4.9	12.6	16.0	8.4	19.5	8.8	26.0	6.6	30.5	6.1	27.0	4.9
	8	4.8	12.7	14.8	6.2	19.0	8.0	24.0	3.4	30.0	1.8	27.0	2.0
	16	4.8	12.7	14.5	5.6	17.5	5.8	23.0	3.0	24.0	0.8	26.0	1.0
	24	4.8	12.7	12.0	4.8	16.5	4.7	23.0	3.0	22.0	0.6	24.0	1.0
F	0	4.0	11.0	19.0	9.3	22.0	9.4	26.8	7.0	30.8	5.7	29.0	5.6
	2	4.0	11.0	16.0	8.3	21.5	8.4	26.8	7.0	31.0	4.8	29.0	5.2
	4	4.0	11.0	15.0	8.0	20.5	7.8	26.0	5.0	30.8	5.0	29.0	4.4
G	0	3.0	11.2	16.5	12.2	21.5	10.2	27.0	8.9	28.0	6.0	27.5	8.6
	2	3.0	10.0	16.0	12.2	19.5	9.8	26.3	8.2	28.0	5.6	27.0	7.8
	4	3.0	10.0	15.0	9.2	18.0	6.8	26.3	6.0	28.0	5.0	27.0	6.0
E	0	4.5	11.5	14.8	6.2	19.5	8.4	27.0	6.8			26.0	3.4

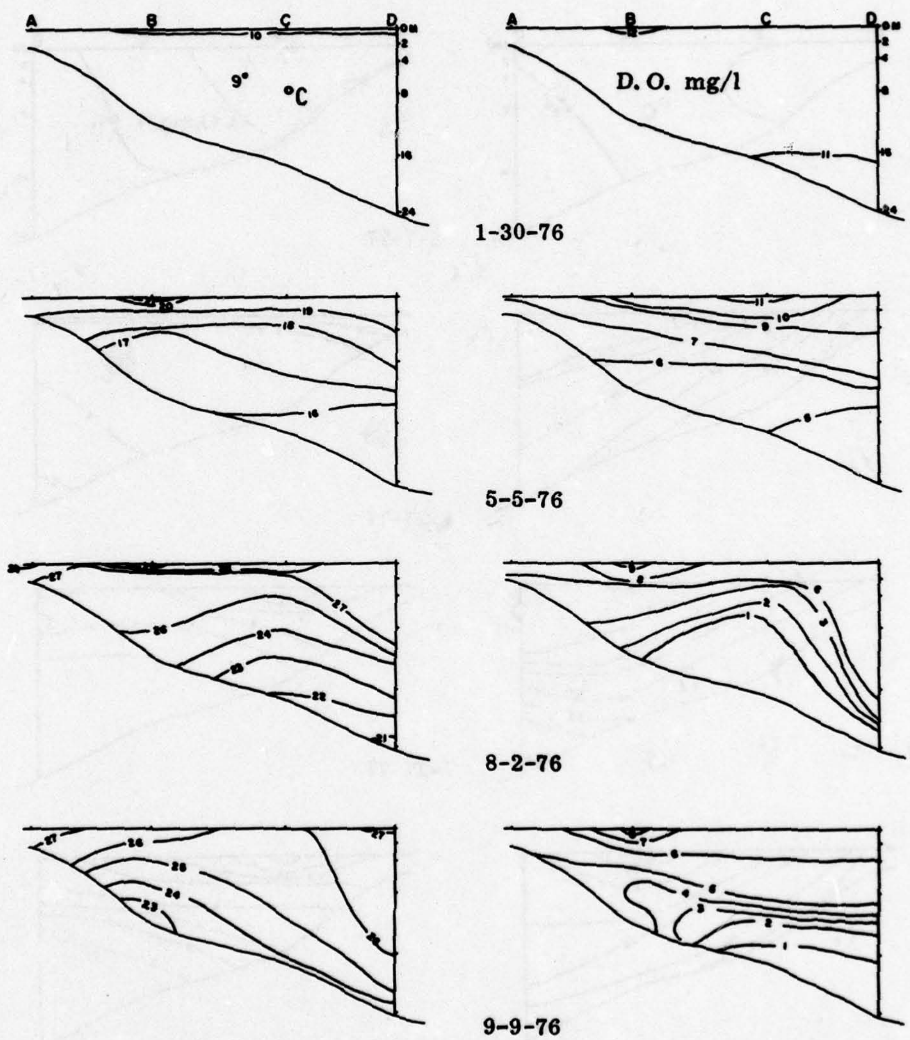


Figure 4. Temperature and D. O. concentration isopleths for West Point Lake on 4 dates in 1976.

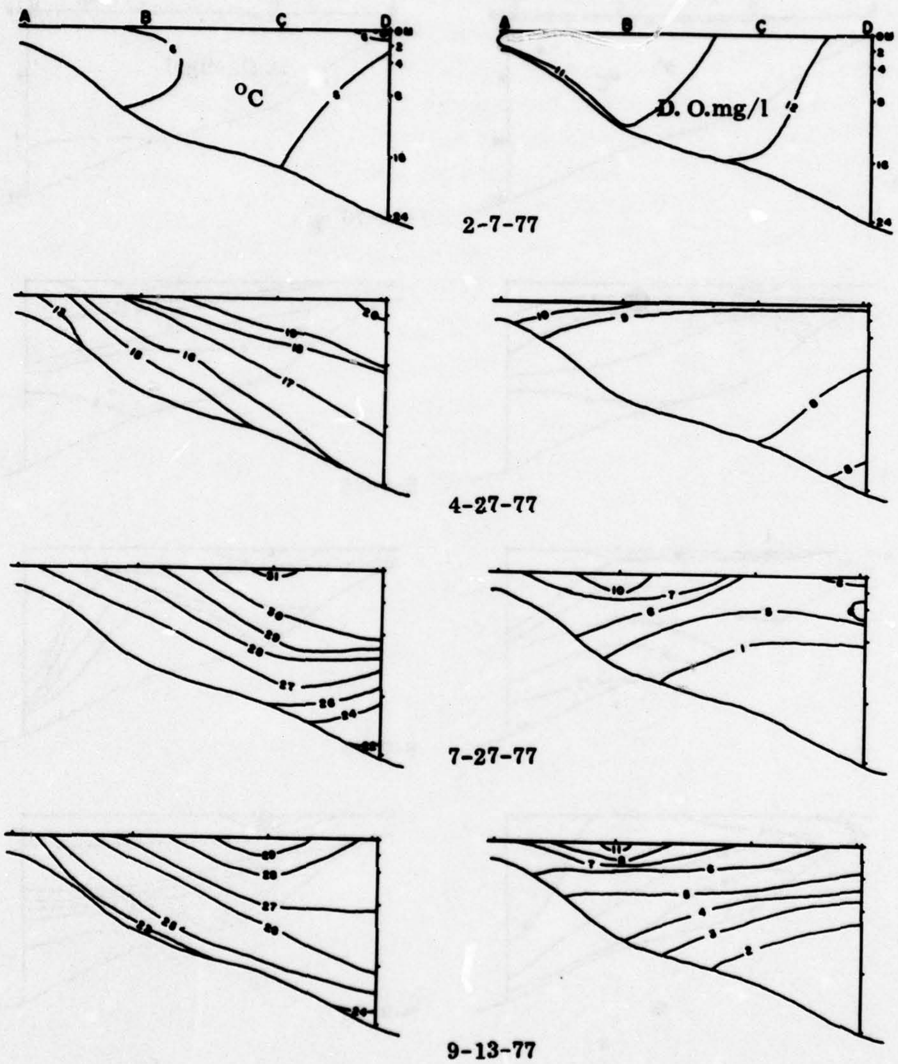


Figure 5. Temperature and D. O. concentration isopleths for West Point Lake on 4 dates in 1977.

temperature while the corresponding D.O. concentrations were depressed 1 to 2 ppm from saturation. On all sampling dates inflowing waters of West Point Lake at Franklin, Georgia, exceeded 5 ppm of D.O.

38. September isopleth patterns indicate that water temperature gradients are still evident from the surface downward and that D.O. concentrations still indicate chemical stratification. Conditions such as these may exist through most of October, or they may be disrupted by late September rains and/or cool nights. When disruptions of the above-mentioned patterns occur this late in the year, there appears to be little likelihood that any significant degree of stratification will reoccur before the onset of cold weather.

39. Isopleth patterns for both water temperature and D.O. concentration indicate that inflowing waters at Franklin, Georgia, have a decided influence upon conditions in the upper half of the lake. On the other hand, the particular circumstances that regulate the level of withdrawal through West Point Dam resulted in limited removal of oxygen-poor bottom waters. Information obtained at tailwater Station E seemingly supports this statement.

40. Monitoring of West Point Dam tailwaters on a 6-week interval did not provide anything other than a comparison of in-lake and downstream conditions at a given instance on a sampling date. While D.O. concentrations less than 5 ppm occurred from July-November 1975, August-September 1976, and July-September 1977, there was no instance of even a minor fish-kill reported.

41. Water temperature and D.O. concentration data from Wehadkee and Yellowjacket Creek were restricted to the 0-, 2-, and 4-m depths (Table 7). During warmer months water temperatures in the upper 4-m column were generally 1° to 2° higher than at Station C in the lake. D.O. concentrations during warmer months showed a greater tendency to be less than 5 ppm at the 4-m level

than at Station C in the lake. Depletion in D.O. concentrations appeared greater in Wehadkee than in Yellowjacket tributary. From these data one would assume that deeper waters in these tributaries would be more oxygen depleted. All causes of these elevated temperatures and depletions of D.O. are unknown, but it is suspected that limited stream flow in these tributaries was a major factor.

42. Water temperature in West Point Lake appears to be dependent solely upon the season of the year and prevailing weather conditions within the drainage area. D.O. concentrations apparently are dependent upon the two above-mentioned factors plus a number of others. Information available on organic loading in this lake does not indicate that this could be a major consumer of D.O. The limited standing crop of phytoplankton did appear to have a decided effect upon D.O. concentrations in surface waters during warmer months of the year.

43. Historically, the only time that severely low (<2 ppm) D.O. concentrations have been observed in surface waters of West Point Lake occurred in September 1975. This overturn condition was produced by hurricane force (75+ mph) winds. This indicates that severe wind storm conditions during the warmer months can disrupt stratification. Under such conditions the depression of surface water D.O. concentrations would depend upon the existing degree of D.O. depletion in the deeper (greater than 4 m) waters of the lake at the time of the storm. The fish life in the lake survived the September 1975 storm. It is not anticipated that such an event would reoccur, but if it does and the surface water (top 4 m) D.O. concentration does not drop below 2 ppm, then the majority of fish life would survive.

44. In situ measurements of light penetration into West Point Lake waters utilized Secchi discs and a submersible Weston photoelectric cell and readout

meter. Secchi disc visibility was measured in cm. The 99 percent light extinction depth, as determined by the photocell, was likewise measured in cm. Data on Secchi disc and 99 percent light extinction depths for each sampling date are given in Table 8. In those instances where Secchi disc visibility was less than 100 cm, the poor visibility was caused by muddy waters. Generally, these muddy waters were the result of watershed erosion, but on one occasion at Station D the muddy water in the surface layer was believed to have been caused by wind-wave bank erosion.

45. Secchi disc data indicate that muddiness was more prevalent at Stations A and B than at downstream lake stations or at tributary stations. On two occasions, in January and April 1976, muddiness was widespread over the whole lake.

46. The general relationship between measured Secchi disc visibility and 99 percent light extinction depth was 1:4. Since the 99 percent light extinction depth is considered to be equivalent to the photic zone, the depth of this zone can be assumed to be 4X Secchi disc visibility (in cm).

47. Turbidity was measured at JTU's[1] on each water sampled collected from West Point Lake. Thus, these data more accurately depict the relative concentrations of suspended matter in waters throughout the length and depth of the lake on sampling dates. The JTU means for each station and its associated depths for each quarter, beginning in October 1974 and extending through December 1975, are summarized in the Appendix Table 2. The quarterly JTU means for each station and its associated depths for the period from January 1976 through September 1977 are given in Table 9.

48. The information available from this study indicates that yearly overall

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[1]JTU's = Jackson Turbidity Units.

Table 8

Secchi disc visibility/99 percent light extinction depths in West Point Lake waters (cm).

Date	A	B	C	D	F	G	E
				Stations			
				Depth in cm			
3-12-75		92					
5-26-75				80/350			
8- 5-75	32/100	130/400		148			
8-19-75		137		153			
9- 9-75	63/275	105/400	115/700	290/800			
11- 1-75	68	78/260	110/400	225/700	224	140	
1-30-76	21	19	18/ 55	43/200	43/170	20	
4- 5-76	41	38/172	26/150	73/220	69/268	46/200	
5- 5-76	70	96/400	145/700	213/600	183/500	172/800	
6- 9-76			83/325		201/500		
8- 2-76	66/270	110/440	142/600	175/550	125/550	142/600	100
9- 9-76	64	128	160	200	135	135	
11- 3-76	76	90	110/500	130/500	115/400	135	
12-14-76	19	60	110	120	110	120	
2- 2-77	90	90/450	110/550	125/600	78	30	
3-16-77	22	35	35/200	115/475	70	80	
4-27-77	42	47	100/400	135/465	130/430	110	
6- 9-77		83	144	160/800	193/850	160/800	
7-27-77			150/550	210/800	150/550		
9-13-77		135	150/750	200/800	150/750	140	

Table 9

Mean turbidities (JTU's) of West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	A	B	C	D	F	G	E
					JTU's			
Jan-	0	70.50	122.50	160.00	34.50	32.50	88.50	55.00
Mar	2		84.00	152.50	32.25	30.25	85.25	
1976	4		84.00	150.00	28.00	27.50	83.00	
	8		85.50	151.00	27.00			
	12-16		86.00	150.00	15.00			
	24				23.00			
Apr-	0	44.16	25.38	30.63	8.40	10.20	15.98	13.70
Jun	2	49.83	28.00	30.55	8.66	10.21	16.11	
	4		28.33	32.25	8.33	11.51	22.38	
	8		31.83	33.51	10.66			
	12-16		27.75	30.52	14.71			
	24				21.75			
Jul-	0	26.50	6.45	5.06	2.95	3.42	2.75	2.00
Sep	2	27.25	7.00	5.17	3.17	3.55	2.92	
	4		7.80	4.62	2.97	3.80	3.55	
	8		28.62	6.40	3.67			
	12-16		22.75	25.00	23.25			
	24				16.25			
Oct-	0	39.87	20.00	7.70	5.60	9.47	5.75	9.55
Dec	2	40.00	20.00	7.45	5.85	9.32	5.90	
	4		20.25	8.75	5.87	10.00	5.70	
	8		20.00	6.60	5.02			
	12-16		11.50	12.15	7.82			
	24				13.22			
Jan-	0	51.00	38.00	24.75	19.75	25.00	18.75	15.75
Mar	2	41.00	37.00	26.00	22.06	24.00	19.25	
1977	4		37.25	27.00	19.25	22.50	16.50	
	8		37.75	22.25	19.10			
	12-16		11.50	19.25	17.77			
	24				28.66			
Apr-	0	29.37	19.35	6.50	7.87	4.77	4.72	5.40
Jun	2	31.37	19.80	7.75	6.57	5.45	4.35	
	4		22.12	7.05	5.07	5.02	5.85	
	8		34.12	7.40	4.97			
	12-16		39.50	30.00	11.62			
	24				32.00			
Jul-	0	44.50	10.60	3.65	2.60	3.32	3.35	7.15
Sep	2	50.00	6.75	5.70	2.22	3.35	3.45	
	4		12.20	4.80	2.25	3.60	3.85	
	8		21.25	11.65	3.22			
	12-16		27.00	29.00	18.75			
	24				39.00			

lake turbidity concentration from greatest to least are winter > spring > fall > summer. It was also indicated that overall turbidity in winter and spring quarters of 1976 was greater than for 1977. Generally, the JTU concentration was higher at Station A and decreased downstream to Station D, but on one occasion in January 1976 this pattern did not hold (Figure 6) and the turbidity was greatest at Station C. This indicates that under high flow rate conditions which are encountered in late summer, the JTU concentration is low and shows small differences between Station A and D (Figure 6).

49. Vertical turbidity concentrations for cooler months usually followed a pattern of higher concentrations from the surface to bottom waters, and in the warmer months the reverse was evident, i.e., surface < bottom waters. This condition is also illustrated in Figure 6.

50. Turbidity in tributary creek areas (Stations F and G) followed the same general seasonal patterns described for the main stem of the lake. The variation in JTU concentrations between these two stations for any quarter reflects a difference in rainfall-erosion activity on the individual watersheds.

51. Turbidity of tailwaters (Station E) was always less than inflowing waters at Station A. During a majority of the quarters in the study period the decrease in turbidity in these tailwaters was severalfold that encountered at Station A.

52. Filterable suspended matter residues were collected by triple filtration of each water sample through a preweighed Gelman glass fiber filter. The dry weight of this residue was determined after the filter and its content reached a constant weight. This technique provided an estimate of the quantity of inorganic and organic suspended matter in lake waters. The filterable residue means for each station and its associated depths for each quarter beginning

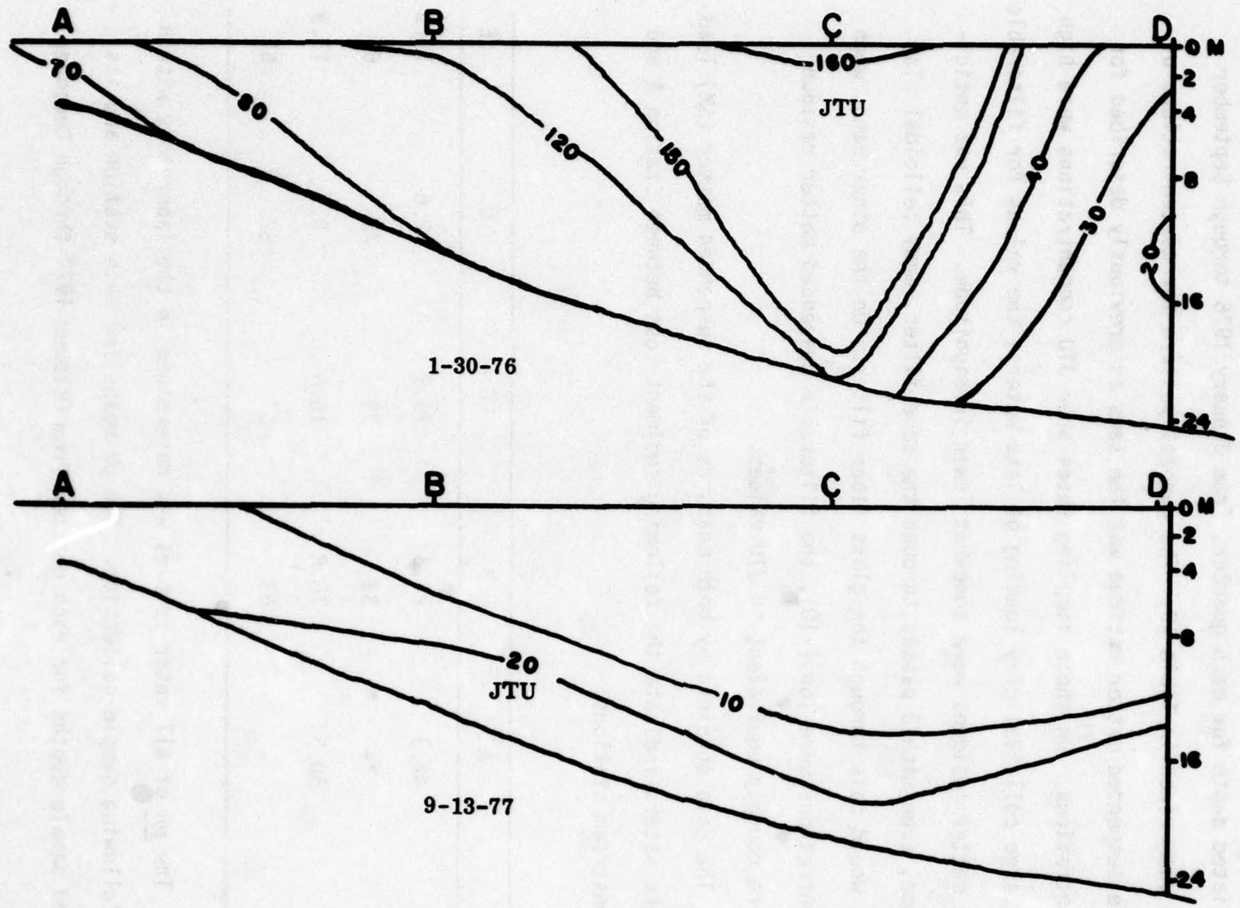

Figure 6. Representative turbidity (JTU) isopleths for West Point Lake for extremely turbid and clear water conditions.

in October 1974 and extending through December 1975 are summarized in Appendix Table 3.

53. The filterable suspended matter residue means for each station and its associated depth for each quarter, from January 1976 through September 1977, are summarized in Table 10. The general pattern for concentrations of filterable suspended matter residue was the same as previously described for JTU concentrations. On those sampling dates when JTU concentrations were high due to a large colloidal clay loading of lake waters, the values for filterable suspended matter residues were somewhat lower in magnitude. This was anticipated since, even with 3 passes through the same filter, many colloidal clay particles would pass through the glass fiber filter. On the other hand, when JTU concentrations were low (<10), the filterable suspended matter residue values were roughly equivalent to JTU values.

54. The data obtained by both measures of the suspended matter (SM) loading of lake waters indicate the following sediment loss between Station A and other downstream stations:

Stations	A	B	C	D	E
JTU $\bar{X}$	42.3	28.3	25.9	12.6	15.5
% loss	-	33	39	70	65
SM ppm $\bar{X}$	50.5	18.8	16.8	8.9	17.9
% loss	-	63	67	82	65

55. The pH of all water samples was determined in the laboratory within 6 hours following sample collection. The pH means for each station and its associated sample depths for each quarter from October 1974 through December

Table 10

Mean suspended matter concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	A	B	C	D	F	G	E
				Station mg/l				
Jan-Mar 1976	0	68.320	53.800	97.150	17.680	13.680	77.760	57.260
	2		40.640	81.560	46.880	13.380	63.800	
	4		55.800	96.000	12.880	14.300	54.440	
	8		46.950	96.600	12.250			
	12-16		47.300	99.960	7.010			
	24				28.960			
Apr-Jun	0	71.446	15.533	19.583	6.228	5.366	6.500	13.924
	2	83.223	19.506	19.213	5.556	5.576	6.340	
	4		22.126	16.466	4.980	5.270	8.163	
	8		30.666	18.396	5.773			
	12-16		24.120	25.368	6.643			
	24				12.576			
Jul-Sep	0	37.910	7.065	8.325	2.245	8.235	3.955	15.025
	2	37.580	6.110	4.292	2.345	4.505	4.700	
	4		11.225	5.435	2.970	4.610	5.510	
	8		14.195	5.792	3.295			
	12-16		5.830	14.360	8.885			
	24				20.880			
Oct-Dec	0	48.330	14.295	11.905	6.420	6.840	6.165	19.800
	2	50.465	17.025	7.580	6.435	8.385	6.080	
	4		17.615	8.240	6.985	7.095	5.240	
	8		17.540	7.870	6.985			
	12-16		11.940	9.600	10.950			
	24				16.795			
Jan-Mar 1977	0	51.710	8.425	9.110	5.010	8.370	8.100	8.360
	2	62.010	7.100	8.405	6.000	9.690	4.590	
	4		18.465	9.310	8.300	10.130	6.730	
	8		10.505	7.745	6.720			
	12-16		6.460	8.355	24.720			
	24				9.400			
Apr-Jun	0	50.460	16.080	13.660	8.950	4.562	4.975	4.920
	2	58.530	16.830	5.180	5.530	4.007	5.545	
	4		22.535	6.870	4.365	4.292	4.375	
	8		19.220	6.607	4.600			
	12-16		22.150	15.415	7.715			
	24				20.790			
Jul-Sep	0	39.040	12.790	4.790	2.080	4.085	4.810	5.740
	2	55.460	7.800	4.035	2.305	3.385	4.620	
	4		10.320	2.825	2.160	4.625	5.505	
	8		45.940	12.590	1.755			
	12-16			29.795	13.240			
	24				37.300			

1975 are summarized in Appendix Table 4. The range observed in pH values for this period was 6.25 to 9.34.

56. The pH means for each station and its associated sample depths for each quarter from January 1976 through September 1977 are given in Table 11. The range observed in pH values for this period was from 5.80 to 8.82. During the colder months of each year there were no appreciable differences in pH values of water samples from any station or from any depth. Practically all pH values for the colder months were less than 7.00. During the warmer months pH values in the surface to 4 meter depth would often exceed 7.00, but only on rare occasions and only at Station B were values exceeding 8.5 obtained.

57. From the information gathered by this study there was no evidence that inflowing river waters were contaminated with any chemicals that exerted an influence on pH. Since the waters were very soft, the principal contributor to the acidic pH was CO_2. Consequently, during warm weather one would anticipate that any appreciable growth of phytoplankton would consume all free CO_2 resulting in increased pH values to 8.5+ during midafternoon. Such a condition was only attained at Station B.

58. Based upon warm weather pH values, the phytoplankton productivity in Wehadkee Creek was minimal. In Yellowjacket Creek the pH values were sometimes greater than 7.00, but they seldom approached 8.5.

59. Statistical analyses of these pH data (Appendix Table 20) indicated that significant differences at $P = 0.0001$ did exist between stations and between periods for waters 2 m or less in depth. For stations where waters were sampled at 4 m and greater depths, significant differences in pH also existed between depths.

Table 11

Mean pH's of West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	A	B	C	Station D	F	G	E
					pH			
Jan-Mar 1976	0	6.33	6.43	6.37	6.58	6.80	6.59	6.85
	2		6.43	6.34	6.61	7.85	6.61	
	4		6.45	6.36	6.65	6.76	6.62	
	8		6.44	6.35	6.71			
	12-16		6.46	6.38	6.71			
	24				6.78			
Apr-Jun	0	6.52	7.20	7.76	7.55	7.29	7.94	6.87
	2	6.62	6.68	7.56	7.32	7.01	7.71	
	4		6.60	6.71	7.03	6.63	6.74	
	8		6.53	6.46	6.72			
	12-16		6.52	6.47	6.32			
	24				6.33			
Jul-Sep	0	6.54	7.48	6.63	7.16	6.63	7.45	6.34
	2	6.59	6.81	6.71	7.17	6.56	7.59	
	4		6.48	6.79	7.12	6.59	7.14	
	8		6.24	6.18	6.78			
	12-16		6.15	6.10	6.20			
	24				6.19			
Oct-Dec	0	6.54	6.60	6.76	6.83	6.68	6.77	6.83
	2	6.58	6.62	6.77	6.85	6.67	6.76	
	4		6.63	6.66	6.79	6.66	6.75	
	8		6.68	6.60	6.77			
	12-16		6.63	6.60	6.72			
	24				6.77			
Jan-Mar 1977	0	6.52	6.64	6.76	7.59	6.77	6.79	6.45
	2	6.57	6.67	6.67		6.73	7.05	
	4		6.67	6.70	7.50	6.69	6.68	
	8		6.66	6.65	6.78			
	12-16		6.91	6.61	6.60			
	24				6.47			
Apr-Jun	0	6.51	6.54	7.12	7.20	6.90	7.79	6.40
	2	6.51	6.51	7.01	7.07	6.85	7.55	
	4		6.48	6.86	6.94	6.53	6.59	
	8		6.40	6.30	6.53			
	12-16		6.36	6.31	6.21			
	24				6.36			
Jul-Sep	0	6.55	9.03	7.33	7.01	6.82	7.52	6.45
	2	6.54	8.38	7.24	6.95	6.75	7.38	
	4		6.56	6.84	6.97	6.66	6.89	
	8		6.44	6.27	6.30			
	12-16			6.29	6.17			
	24				6.22			

60. Specific conductance (μmhos/cm) measurements were made on all samples of water collected from West Point Lake. The μmhos/cm means for each station and associated sampling depths for each quarter between October 1974 and December 1975 are summarized in Appendix Table 5. For the period from January 1976 through September 1977 the μmhos means for each station and associated depths are given in Table 12.

61. The general pattern for quarterly specific conductance values throughout the study period was winter < spring < fall < summer. During 1976 the specific conductance values were greater at Station A and gradually decreased downstream to the dam. Tailwater values for that year ranged from 40 to 50. During 1977 the water inflow rate was somewhat less than for the previous year. This resulted in slightly increased values, but random patterns throughout the lake for both the winter and spring quarters. These patterns reflect the influence of varying degrees of turbidity upon specific conductance values, i.e., the more turbid the waters the more depressed the values. During the summer quarter of 1977 specific conductance means ranged from 50 to 87.5. This again reflected the clear water condition of the entire lake and the resulting concentration of salts that resulted from lack of dilution (low flows). The mean tailwater specific conductance values for 1977 ranged from 50.0 to 67.5.

62. Statistical analyses indicate that in 0- to 4-m depths significant differences ($P = 0.0001$) existed between specific conductance values of stations and of periods. At stations where water samples were collected at depths greater than 4 m, specific conductance values between depths were significant at $P = 0.0018$.

63. Free carbon dioxide (CO_2) concentrations in lake waters were determined in the laboratory within 6 hours of the time samples were collected.

Table 12

Mean umhos (specific conductance) of West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	A	B	C	D	F	G	E
					umhos			
Jan-	0	32.1	25.8	25.0	29.7	24.3	28.6	40.4
Mar	2		28.6	25.9	32.1	25.9	27.7	
1976	4		28.6	25.0	32.1	25.0	29.7	
	8		27.7	25.0	30.6			
	12-16		30.8	25.9	36.1			
	24				30.8			
Apr-	0	38.9	34.0	35.9	37.2	31.7	37.8	39.2
Jun	2	38.9	34.0	35.5	36.0	30.2	37.8	
	4		35.5	35.5	37.8	31.0	37.1	
	8		35.5	36.4	37.8			
	12-16		36.7	36.5	39.3			
	24				41.7			
Jul-	0	66.8	66.9	45.0	45.0	53.3	45.2	50.0
Sep	2	66.9	66.9	45.0	45.0	32.7	48.5	
	4		66.9	45.0	45.0	32.7	48.5	
	8		58.5	45.0	45.0			
	12-16		67.0	48.5	50.0			
	24				58.4			
Oct-	0	51.8	45.0	45.0	45.0	40.5	45.0	50.0
Dec	2	50.0	45.0	45.0	50.0	40.5	45.0	
	4		45.0	45.0	50.0	41.7	45.0	
	8		45.0	45.0	50.0			
	12-16		50.0	45.0	50.0			
	24				50.0			
Jan-	0	38.9	45.0	41.7	45.0	28.6	36.7	50.0
Mar	2	41.7	43.2	43.2	46.0	25.0	36.7	
1977	4		41.7	41.7	45.0	25.0	36.7	
	8		41.7	41.7	50.0			
	12-16			45.0	50.0			
	24				50.0			
Apr-	0	36.7	66.7	53.4	45.0	40.0	41.7	53.4
Jun	2	36.7	66.7	53.4	45.0	36.7	50.0	
	4		53.4	53.4	45.0	36.7	50.0	
	8		53.4	53.4	45.0			
	12-16		66.7	53.4	45.0			
	24				45.0			
Jul-	0	81.2	75.0	67.5	67.5	67.5	67.5	67.5
Sep	2	81.2	67.5	67.5	67.5	50.0	67.5	
	4		67.5	67.5	67.5	50.0	67.5	
	8		67.5	67.5	67.5			
	12-16			87.5	75.0			
	24				87.5			

During the first year of impoundment observed free CO_2 concentrations in West Point Lake water ranged from 0 to 4.23 mg/l. Mean concentrations of free CO_2 for each station and associated sampling depths for each quarter from October 1974 through December 1975 are summarized in Appendix Table 6.

64. For the period January 1976 through September 1977 the observed free CO_2 concentrations in West Point Lake waters ranged from 0 to 15.40 mg/l. The free CO_2 concentration means for each station and associated sampling depths for each quarter from January 1976 through September 1977 are given in Table 13.

65. In general, the variations in free CO_2 concentrations in the 0- to 4-m layer of water showed limited but random variation associated with time. In this same water layer there was a general trend from a higher to lower concentration of free CO_2 from Station A to Station D. Vertically, there were increases in concentrations of free CO_2 from 4 m to the lowest depth sampled at Stations B, C, and D during all warm weather sampling dates. During colder months vertical concentrations of free CO_2 were approximately the same.

66. During the April-June quarter of both years, the 0- to 2-m depths in Wehadkee and Yellowjacket Creeks showed markedly decreased concentrations of free CO_2. This possibly was caused by a spring bloom of phytoplankton. During other periods of the year the quantities of free CO_2 in the creek embayments were similar to conditions on the lower reaches of the main stem of the lake.

67. Statistical analysis indicates significant differences at P = 0.0001 between stations and periods for depths of 0 and 2 m. At stations with water samples from depths greater than 2 m there was also a significant difference at P = 0.0001 for CO_2 concentrations between depths.

68. Total alkalinity (mg/l as $CaCO_3$) determinations were accomplished in the laboratory within 6 hours following the collection of water samples. The

Table 13

Mean free carbon dioxide concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	A	B	C	Station D	F	G	E
					mg/l			
Jan-	0	2.31	1.98	2.14	1.76	1.37	1.92	1.60
Mar	2		1.98	2.20	1.81	1.43	1.92	
1976	4		2.03	2.25	1.65	1.48	1.87	
	8		2.14	2.31	1.54			
	12-16		2.03	2.04	1.59			
	24				1.48			
Apr-	0	1.74	1.00	0.71	0.46	0.87	0.50	1.84
Jun	2	1.81	1.54	0.82	0.62	0.75	0.55	
	4		1.72	1.70	0.77	2.62	1.63	
	8		2.12	2.31	1.69			
	12-16		2.25	2.64	3.77			
	24				5.42			
Jul-	0	2.44	0.68	1.89	0.66	2.06	0.80	5.11
Sep	2	2.25	1.40	1.60	0.60	2.31	0.88	
	4		2.39	1.54	0.58	2.36	1.18	
	8		4.12	4.51	1.65			
	12-16		3.74	9.13	7.78			
	24				12.40			
Oct-	0	2.11	1.98	1.79	1.24	1.98	2.06	1.35
Dec	2	1.84	2.00	1.65	1.12	2.03	2.11	
	4		1.98	1.78	1.29	2.17	2.11	
	8		1.90	1.84	1.32			
	12-16		1.87	1.92	1.57			
	24				1.37			
Jan-	0	2.27	1.98	1.37	0.66	1.23	1.32	4.97
Mar	2	2.09	1.78	1.76	0.86	1.29	1.29	
1977	4		1.81	1.67	0.74	1.54	1.90	
	8		1.98	1.81	1.29			
	12-16		1.54	2.22	1.89			
	24				2.82			
Apr-	0	1.26	1.95	0.90	0.57	0.85	0.25	4.54
Jun	2	1.21	1.98	1.18	0.66	0.99	0.27	
	4		2.64	1.24	0.80	1.78	2.14	
	8		4.18	3.08	2.45			
	12-16		6.76	4.07	4.67			
	24				5.17			
Jul-	0	2.61	0	0.85	0.96	1.48	0.63	3.87
Sep	2	4.94	0.14	0.72	0.90	1.60	0.68	
	4		1.81	1.23	0.94	2.00	1.26	
	8		1.87	4.64	4.70			
	12-16		3.46	9.01	8.69			
	24				12.70			

total alkalinity means for each station and associated sampling depths for each quarter from October 1974 through December 1975 are summarized in Appendix Table 7. Observed total alkalinity concentrations during this period ranged from 10.75 to 40.00 mg/l $CaCO_3$.

69. Total alkalinity concentration means for each station and associated sampling depths from January 1976 through September 1977 are given in Table 14. The range observed in total alkalinity concentration for this period was from 7.25 to 41.75 mg/l. Some degree of seasonal change in total alkalinity concentrations was evident, i.e., lower overall concentrations occurred in the colder months. In warmer months, vertical concentrations were approximately the same in the photic zone (to 8 m depth) but increased approximately twofold in bottom waters.

70. In Wehadkee Creek the total alkalinity concentration followed the same seasonal pattern as described above, with values being in the range of 10 to 17 mg/l $CaCO_3$ for the entire period of study. In Yellowjacket Creek the seasonal pattern was evident, but concentrations of total alkalinity ranged from 11 to 21 mg/l $CaCO_3$. In both creeks the higher concentrations occurred in warmer months.

71. Tailwater concentrations of total alkalinity varied seasonally with values generally being slightly greater than those of inflowing waters at Station A.

72. Statistical analysis of these total alkalinity data for 0- to 4-m depths indicated that significant differences at P = 0.0001 existed between stations and between periods. For depths greater than 4 m, significant differences at P = 0.002 existed between stations, between depths, and between periods.

Table 14

Mean total alkalinity (expressed as ppm $CaCO_3$) concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	A	B	C	Station D	F	G	E
					mg/l			
Jan-	0	8.87	7.87	7.37	12.12	12.12	11.37	14.00
Mar	2		8.25	7.37	12.62	11.75	11.37	
1976	4		8.12	7.37	12.75	11.75	11.62	
	8		8.37	7.50	13.37			
	12-16		8.25	8.12	13.37			
	24				13.75			
Apr-	0	12.45	11.58	11.95	12.37	12.04	14.79	12.40
Jun	2	12.20	11.66	12.29	12.12	12.00	15.00	
	4		11.54	11.33	12.08	11.91	12.04	
	8		11.75	11.25	12.20			
	12-16		11.56	12.10	12.20			
	24				15.91			
Jul-	0	14.56	12.93	15.18	15.06	15.56	17.06	20.12
Sep	2	14.18	12.87	14.93	14.87	15.56	16.62	
	4		13.12	14.75	14.81	15.62	16.25	
	8		13.12	14.75	14.68			
	12-16		14.50	24.43	22.12			
	24				32.62			
Oct-	0	15.06	15.56	16.12	14.87	17.00	20.19	14.56
Dec	2	15.37	15.87	15.81	14.68	16.75	20.00	
	4		15.87	15.62	15.00	16.56	20.50	
	8		15.50	15.31	15.06			
	12-16		16.25	15.56	15.00			
	24				15.18			
Jan-	0	14.41	14.68	13.62	12.56	11.25	15.81	15.25
Mar	2	15.68	14.56	13.93	12.65	10.93	15.43	
1977	4		14.37	13.93	12.75	11.50	15.12	
	8		14.37	14.00	12.81			
	12-16		19.00	14.15	13.18			
	24				13.66			
Apr-	0	10.25	13.31	12.93	11.81	11.50	13.93	14.68
Jun	2	9.87	13.31	12.18	11.87	11.06	13.62	
	4		13.50	12.50	11.06	11.25	13.56	
	8		17.50	12.75	11.62			
	12-16		25.25	15.81	13.37			
	24				19.62			
Jul-	0	17.12	14.62	16.87	15.50	16.00	18.00	20.75
Sep	2	16.25	14.12	16.25	15.62	15.37	17.62	
	4		12.75	15.87	15.25	15.12	17.25	
	8		12.87	20.12	17.37			
	12-16			39.37	34.37			
	24				35.25			

73. Total inorganic nitrogen includes ammonia N + nitrate N as determined for each sample of West Point Lake water. This value for N concentration is used in all calculations in this study since phytoplankton can utilize both the ammonia and nitrate forms in their metabolism. The concentration as the nitrite form was so insignificant (less than 5 percent) that its inclusion in calculations makes no practical difference. The mean inorganic N concentrations for each station and associated sampling depths for each quarter from October 1974 through December 1975 are given in Appendix Table 8. The range observed in total inorganic N for this period was from 0.013 to 5.072 mg N/l.

74. Mean total inorganic N concentrations for each station and associated sampling depths for each quarter from January 1976 through September 1977 are given in Table 15. Ammonia N and nitrate N means for each station and associated sampling depths for each of these quarters are given in Tables 16 and 17. During this period observed total inorganic N concentrations ranged from 0.006 to 3.203 mg N/l. Variations in total inorganic N concentrations associated with time, stations, and depth were very pronounced as shown in Figure 7. On the main stem of the lake decreases in total inorganic N concentrations in surface waters (0- to 8-m depths) from Station A to D occurred in warmer months. During the spring quarters there was a decreased N concentration in waters coming into the lake at Station A, but during summer quarters N inflow concentration returned to values comparable to colder quarter inflows. During warmer months and particularly during summer quarters the total inorganic N in waters deeper than 8 m increased significantly.

75. Total inorganic N concentrations in Wehadkee and Yellowjacket Creek tributaries followed the same general patterns as described for the main stem of the lake. One obvious difference was that tributary N concentrations did

Table 15

Mean total inorganic nitrogen (NH_3 + NO_2 + NO_3 forms) concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	A	B	C	Station D	F	G	E
					mg/l			
Jan-	0	0.805	0.639	1.018	1.161	0.285	0.736	0.651
Mar	2		0.755	0.661	0.994	0.342	0.687	
1976	4		0.585	0.584	1.124	0.557	1.009	
	8		0.655	0.879	1.185			
	12-16		0.647	1.014	0.813			
	24				0.782			
Apr-	0	0.970	0.911	0.684	0.630	0.610	0.619	0.975
Jun	2	0.988	0.872	0.608	0.779	0.506	0.595	
	4		0.980	0.820	0.710	0.596	0.938	
	8		1.087	1.051	0.850			
	12-16		0.977	1.168	1.194			
	24				1.287			
Jul-	0	1.663	1.157	1.142	0.454	0.897	0.974	1.880
Sep	2	1.663	1.142	0.978	0.461	0.853	0.970	
	4		1.415	1.080	0.534	0.653	0.974	
	8		1.683	1.444	0.645			
	12-16		1.328	1.619	1.969			
	24				2.325			
Oct-	0	1.767	1.766	1.466	1.074	0.995	1.253	1.189
Dec	2	1.739	1.648	1.351	0.918	1.008	1.349	
	4		1.733	1.363	1.014	0.992	1.307	
	8		1.790	1.495	1.220			
	12-16		1.657	1.497	1.353			
	24				1.336			
Jan-	0	1.796	1.497	1.389	1.248	0.773	0.832	1.225
Mar	2	1.713	1.507	1.390	1.282	0.908	0.853	
	4		1.483	1.457	1.230	1.021	1.106	
	8		1.565	1.460	1.283			
	12-16		1.834	1.389	1.347			
	24				1.122			
Apr-	0	0.832	0.932	0.558	0.532	0.116	0.432	0.381
Jun	2	0.691	0.839	0.555	0.261	0.219	0.429	
	4	0.	1.015	0.624	0.386	0.277	0.541	
	8		1.063	0.831	0.429			
	12-16		1.252	0.850	0.844			
	24				1.179			
Jul-	0	1.921	1.166	1.134	1.075	0.859	0.972	1.190
Sep	2	1.898	1.265	0.757	0.906	0.792	0.851	
	4		1.544	1.011	0.989	0.737	1.138	
	8		1.433	1.612	1.302			
	12-16		1.852	1.687	1.611			
	24				1.546			

Table 16

Mean ammonia nitrogen concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	A	B	C	Station D mg/l	F	G	E
Jan - Mar 1976	0	0.190	0.055	0.492	0.515	0	0.185	0
	2		0.165	0.130	0.362	0.050	0.130	
	4		0	0.060	0.495	0.260	0.455	
	8		0.060	0.355	0.540			
	12-16		0.060	0.470	0.155			
	24				0.117			
Apr- Jun	0	0.330	0.432	0.363	0.359	0.491	0.493	0.584
	2	0.382	0.317	0.247	0.503	0.405	0.469	
	4		0.420	0.334	0.430	0.455	0.509	
	8		0.523	0.521	0.439			
	12-16		0.397	0.595	0.652			
	24				0.825			
Jul- Sep	0	0.975	0.495	0.732	0.390	0.586	0.791	1.176
	2	0.975	0.455	0.585	0.398	0.545	0.781	
	4		0.737	0.703	0.471	0.638	0.775	
	8		1.006	0.962	0.421			
	12-16		0.680	1.381	1.282			
	24				1.532			
Oct- Dec	0	1.060	1.067	0.777	0.396	0.853	0.722	0.527
	2	1.040	0.968	0.670	0.248	0.872	0.820	
	4		1.035	0.681	0.336	0.860	0.777	
	8		1.113	0.800	0.542			
	12-16		0.945	0.825	0.692			
	24				0.656			
Jan- Mar 1977	0	1.118	0.883	0.788	0.625	0.503	0.440	0.613
	2	1.052	0.901	0.781	0.667	0.641	0.446	
	4		0.875	0.847	0.607	0.745	0.659	
	8		0.946	0.849	0.656			
	12-16		1.197	0.778	0.727			
	24				0.479			
Apr- Jun	0	0.228	0.325	0	0.307	0.067	0.048	0.107
	2	0.083	0.231	0	0.045	0.165	0.057	
	4		0.401	0.061	0.147	0.211	0.047	
	8		0.667	0.251	0.090			
	12-16		1.235	0.553	0.472			
	24				0.958			
Jul- Sep	0	1.149	0.837	0.782	0.838	0.817	0.794	1.082
	2	1.130	0.841	0.572	0.731	0.716	0.668	
	4		0.962	0.687	0.785	0.718	0.897	
	8		0.890	1.096	1.206			
	12-16		1.202	1.413	1.444			
	24				1.416			

Table 17

Mean nitrate nitrogen concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	A	B	C	Station D	F	G	E
					mg/l			
Jan-Mar 1976	0	0.610	0.574	0.515	0.640	0.280	0.545	0.640
	2		0.581	0.526	0.624	0.289	0.547	
	4		0.579	0.519	0.622	0.289	0.547	
	8		0.588	0.516	0.639			
	12-16		0.578	0.537	0.648			
	24				0.656			
Apr-Jun	0	0.627	0.470	0.312	0.264	0.115	0.120	0.382
	2	0.592	0.548	0.355	0.267	0.098	0.121	
	4		0.553	0.478	0.271	0.137	0.420	
	8		0.555	0.521	0.399			
	12-16		0.569	0.562	0.531			
	24				0.446			
Jul-Sep	0	0.627	0.633	0.391	0.057	0.308	0.173	0.698
	2	0.627	0.660	0.379	0.059	0.305	0.181	
	4		0.650	0.360	0.057	0.012	0.187	
	8		0.652	0.459	0.217			
	12-16		0.671	0.629	0.224			
	24				0.788			
Oct-Dec	0	0.674	0.670	0.671	0.647	0.132	0.510	0.630
	2	0.668	0.655	0.662	0.640	0.128	0.507	
	4		0.672	0.663	0.648	0.123	0.508	
	8		0.652	0.676	0.648			
	12-16		0.672	0.645	0.630			
	24				0.653			
Jan-Mar 1977	0	0.665	0.605	0.591	0.614	0.268	0.386	0.601
	2	0.648	0.598	0.600	0.606	0.263	0.399	
	4		0.597	0.601	0.614	0.273	0.441	
	8		0.609	0.600	0.619			
	12-16		0.632	0.302	0.612			
	24				0.634			
Apr-Jun	0	0.588	0.572	0.543	0.217	0.046	0.371	0.270
	2	0.594	0.577	0.541	0.209	0.053	0.361	
	4		0.585	0.546	0.234	0.063	0.484	
	8		0.384	0.561	0.336			
	12-16		0.011	0.285	0.364			
	24				0.213			
Jul-Sep	0	0.589	0.441	0.256	0.125	0.007	0.128	0.138
	2	0.606	0.450	0.286	0.110	0.006	0.136	
	4		0.589	0.328	0.123	0.006	0.241	
	8		0.610	0.415	0.153			
	12-16		0.621	0.286	0.161			
	24				0.008			

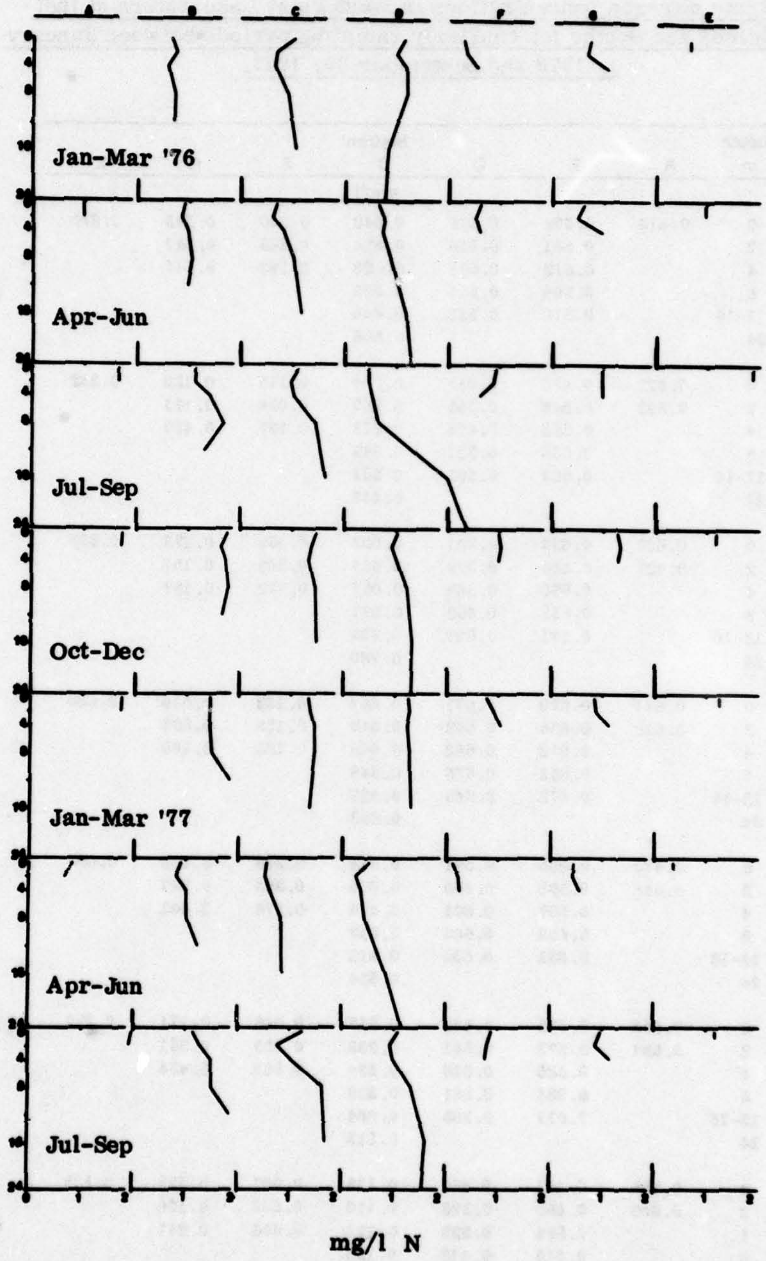

Figure 7. Mean total inorganic N concentrations in West Point Lake at each station and depth for each quarter from January 1976 to September 1977.

not exhibit as great a variation in concentration as was encountered on the main stem.

76. Total inorganic N concentrations in tailwaters generally followed seasonal variations similar to the inflow pattern at Station A.

77. Overall mean total inorganic N concentration in West Point Lake waters consisted of 53 percent ammonia N, 43 percent nitrate N, and 4 percent nitrite N.

78. Statistical analyses of total inorganic N data for 0- to 4-m water depths indicated that significant differences, at P = 0.0001, in concentrations existed between stations and between periods. For waters deeper than 4 m, significant differences also existed between depths.

79. Ortho + particulate phosphorus includes the soluble ortho P determined on water passed through a 0.45-μ Millipore filter plus the P retained on filter pads (referred to as particulate P). The ortho + particulate P means for each station and associated sampling depths for each quarter from October 1974 through December 1975 are given in Appendix Table 11. The range observed in ortho + particulate P concentrations in lake waters during this period was from 0 to 1.005 mg/l.

80. The ortho + particulate P means for each station and associated sampling depths for each quarter from January 1976 through September 1977 are given in Table 18. The range observed in ortho + particulate P for this period was from 0.015 to 0.567 mg/l. Concentrations of ortho + particulate P in West Point Lake waters varied in somewhat of a random manner as shown in Figure 8. In this figure the value for ortho P concentration (Table 19) is shown as a dotted line while the ortho P + particulate P (Table 20) is indicated by the solid line. A notable event in sample analysis is evident in Jan-Mar and

Table 18

Mean total inorganic phosphorus concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	A	B	C	Station D	F	G	E
					mg/l			
Jan-	0	0.094	0.043	0.063	0.104	0.041	0.050	0.076
Mar	2		0.071	0.040	0.082	0.042	0.063	
1976	4		0.069	0.061	0.088	0.015	0.052	
	8		0.055	0.288	0.111			
	12-16		0.055	0.060	0.071			
	24				0.085			
Apr-	0	0.324	0.155	0.157	0.109	0.038	0.098	0.076
Jun	2	0.377	0.158	0.145	0.123	0.067	0.105	
	4		0.183	0.126	0.115	0.051	0.085	
	8		0.147	0.092	0.093			
	12-16		0.137	0.128	0.085			
	24				0.110			
Jul-	0	0.459	0.226	0.185	0.134	0.238	0.191	0.285
Sep	2	0.459	0.231	0.156	0.112	0.223	0.173	
	4		0.252	0.164	0.173	0.261	0.214	
	8		0.280	0.214	0.182			
	12-16		0.302	0.257	0.237			
	24				0.319			
Oct-	0	0.423	0.403	0.311	0.220	0.262	0.219	0.247
Dec	2	0.407	0.426	0.316	0.208	0.265	0.215	
	4		0.413	0.327	0.195	0.268	0.234	
	8		0.417	0.302	0.205			
	12-16		0.453	0.342	0.194			
	24				0.224			
Jan-	0	0.407	0.374	0.339	0.311	0.304	0.327	0.308
Mar	2	0.433	0.365	0.337	0.287	0.313	0.301	
1977	4		0.389	0.337	0.289	0.296	0.283	
	8		0.375	0.344	0.301			
	12-16		0.413	0.377	0.319			
	24				0.325			
Apr-	0	0.391	0.283	0.289	0.275	0.261	0.274	0.263
Jun	2	0.354	0.272	0.292	0.264	0.261	0.247	
	4		0.288	0.268	0.252	0.262	0.255	
	8		0.294	0.259	0.261			
	12-16		0.319	0.283	0.272			
	24				0.269			
Jul-	0	0.515	0.304	0.293	0.306	0.295	0.281	0.315
Sep	2	0.514	0.314	0.216	0.251	0.239	0.244	
	4		0.359	0.288	0.192	0.213	0.277	
	8		0.389	0.277	0.248			
	12-16		0.423	0.337	0.357			
	24				0.413			

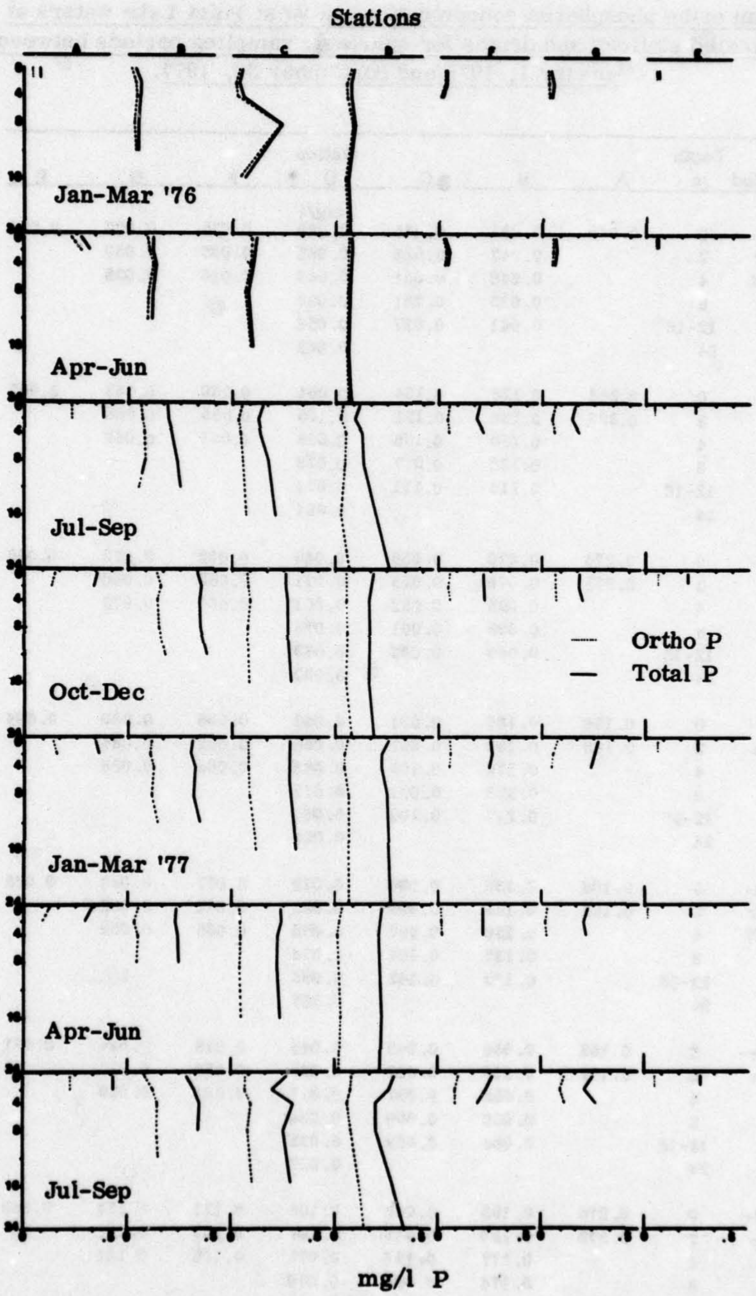

Figure 8. Mean concentrations of ortho and total P in West Point Lake waters at given stations for each quarter from January 1976 through September 1977.

Table 19

Mean ortho phosphorus concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	A	B	C	Station D	F	G	E
					mg/l			
Jan-	0	0.055	0.021	0.045	0.086	0.035	0.027	0.060
Mar	2		0.047	0.025	0.062	0.035	0.039	
1976	4		0.048	0.031	0.069	0.010	0.035	
	8		0.035	0.261	0.097			
	12-16		0.041	0.027	0.056			
	24				0.065			
Apr-	0	0.281	0.128	0.134	0.094	0.030	0.082	0.065
Jun	2	0.329	0.136	0.121	0.105	0.055	0.088	
	4		0.160	0.106	0.098	0.041	0.069	
	8		0.126	0.077	0.078			
	12-16		0.110	0.111	0.073			
	24				0.094			
Jul-	0	0.274	0.070	0.059	0.045	0.062	0.079	0.046
Sep	2	0.275	0.079	0.035	0.031	0.053	0.060	
	4		0.095	0.052	0.061	0.064	0.075	
	8		0.098	0.061	0.075			
	12-16		0.060	0.082	0.033			
	24				0.080			
Oct-	0	0.180	0.166	0.091	0.063	0.066	0.080	0.094
Dec	2	0.163	0.190	0.097	0.065	0.052	0.064	
	4		0.172	0.109	0.063	0.065	0.088	
	8		0.178	0.091	0.071			
	12-16		0.217	0.109	0.061			
	24				0.096			
Jan-	0	0.168	0.135	0.099	0.072	0.067	0.090	0.075
Mar	2	0.192	0.125	0.099	0.062	0.072	0.062	
1977	4		0.150	0.098	0.055	0.065	0.052	
	8		0.135	0.104	0.078			
	12-16		0.170	0.142	0.085			
	24				0.087			
Apr-	0	0.152	0.065	0.049	0.045	0.019	0.034	0.021
Jun	2	0.112	0.040	0.053	0.027	0.022	0.021	
	4		0.058	0.057	0.017	0.024	0.029	
	8		0.050	0.050	0.024			
	12-16		0.080	0.059	0.033			
	24				0.027			
Jul-	0	0.276	0.103	0.087	0.105	0.121	0.138	0.080
Sep	2	0.279	0.150	0.087	0.099	0.107	0.117	
	4		0.177	0.136	0.077	0.105	0.142	
	8		0.174	0.098	0.096			
	12-16		0.183	0.128	0.147			
	24				0.176			

Table 20

Mean particulate phosphorus concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	Station A	B	C	D	F	G	E
					mg/l			
Jan-Mar 1976	0	0.039	0.022	0.017	0.018	0.006	0.022	0.016
	2		0.024	0.015	0.020	0.007	0.024	
	4		0.020	0.030	0.019	0.005	0.017	
	8		0.020	0.027	0.013			
	12-16		0.014	0.033	0.015			
	24				0.020			
Apr-Jun	0	0.042	0.026	0.023	0.014	0.008	0.015	0.010
	2	0.048	0.022	0.023	0.017	0.011	0.017	
	4		0.022	0.019	0.016	0.009	0.015	
	8		0.020	0.014	0.014			
	12-16		0.026	0.016	0.011			
	24				0.015			
Jul-Sep	0	0.185	0.156	0.126	0.089	0.175	0.111	0.239
	2	0.183	0.151	0.120	0.081	0.170	0.113	
	4		0.156	0.112	0.112	0.196	0.138	
	8		0.182	0.153	0.107			
	12-16		0.242	0.175	0.204			
	24				0.239			
Oct-Dec	0	0.242	0.237	0.220	0.156	0.199	0.138	0.153
	2	0.243	0.235	0.219	0.143	0.213	0.131	
	4		0.240	0.217	0.132	0.202	0.145	
	8		0.239	0.211	0.133			
	12-16		0.236	0.233	0.133			
	24				0.148			
Jan-Mar 1977	0	0.239	0.239	0.239	0.239	0.237	0.236	0.233
	2	0.240	0.239	0.237	0.234	0.240	0.239	
	4		0.238	0.238	0.233	0.231	0.231	
	8		0.239	0.239	0.223			
	12-16		0.243	0.234	0.233			
	24				0.237			
Apr-Jun	0	0.239	0.218	0.239	0.227	0.242	0.240	0.242
	2	0.242	0.232	0.239	0.236	0.239	0.226	
	4		0.230	0.210	0.235	0.238	0.226	
	8		0.243	0.206	0.236			
	12-16		0.239	0.224	0.239			
	24				0.242			
Jul-Sep	0	0.239	0.201	0.206	0.200	0.173	0.142	0.235
	2	0.234	0.163	0.128	0.151	0.131	0.127	
	4		0.182	0.151	0.114	0.113	0.134	
	8		0.215	0.179	0.152			
	12-16		0.240	0.208	0.209			
	24				0.237			

Apr-June 1976 quarters (Figure 8) where the quantity of particulate P was often less than quantity of ortho P. This was a condition that was found to exist in several different habitats being sampled by this laboratory during the same period. The cause of the low particulate P values is unknown. For the remainder of the study period there was a decrease in ortho P and consequently total P concentrations from Station A to the dam.

81. In both Wehadkee and Yellowjacket Creeks the concentration of ortho P was less than the quantity present at Station A and generally was equal to or less than the concentration present in front of the dam. Over the entire span of the study period there is little evidence of any marked differences in ortho P or ortho + particulate P in either creek. Tailwater concentrations of total P were approximately the same as those existing in the water column above the dam. It is evident from Figure 8 that particulate P accounted for a large portion of the total P in these discharged waters.

82. Statistical analyses of ortho P data indicated that statistical differences at P = 0.0001 in concentrations existed between stations and between periods. For data collected in waters deeper than 4 m, significant differences at P = 0.02 in concentrations existed between depths. Analyses of the particulate P data yielded similar statistical information to that obtained for ortho P.

83. The total yearly accumulation of inorganic P was calculated to be 1,210,193 kg of which 576,697 kg was from ortho P and 633,496 kg was from particulate P. Based upon the total yearly inflow of 2,573,102 kg, this was a 47 percent accumulation rate.

84. Calculated inflow, retention, and outflow of ortho P and particulate P in West Point Lake are presented by quarters in Tables 21 and 22. The

Table 21

Quarterly mean concentrations of ortho P for West Point Lake including loading rates, inflow loading, accumulation, and outflow loading based upon mean quarterly inflow and outflow rates.

Time period	$\bar{z}$(m)	Tw yr.	Ortho P $(G/m^3/q)$	loading rate $(kg/km^2/day)$	Mean P ug/l	Inflow rate m^3/sec	Outflow rate m^3/sec	Inflow load kg/q	Outflow load kg/q	Accumulation kg/q
Jan - Mar '76	7.1	.08	1.06	.1374	55	290.2	275.5	111,411	129,948	18,537
Apr - Jun	7.1	.10	4.17	.5307	252	292.2	228.8	437,573	107,926	329,647
Jul - Sep	7.1	.19	2.32	.2904	274	146.7	127.4	242,779	46,046	196,733
Oct - Dec	7.1	.22	1.75	.2265	172	164.8	109.8	183,620	81,172	102,448
Jan - Mar '77	7.1	.12	2.03	.2625	180	194.6	162.8	212,801	96,005	116,796
Apr - Jun	7.1	.10	1.63	.2113	132	224.9	185.8	171,310	30,667	140,643
Jul - Sep	7.1	.20	1.92	.2406	277	117.9	95.5	201,550	60,060	141,490

Note. Comparative information on similar studies conducted in West Point Lake and other Southeastern impoundments is presented in the following publications:

West Point Reservoir Monitoring Project
May - November, 1975. Ga. Dept. Nat.
Res., Enviro. Protection Div., Oct. 1976. 131 pp.

West Point Lake Postimpoundment Study
EPA Region IV, Surveillance and Analysis
Div., Athens, Ga., Nov. 1976. 90 pp.

Table 22

Quarterly mean concentrations of particulate P for West Point Lake including loading rates, inflow loading, accumulation, and outflow loading based upon mean quarterly inflow and outflow rates.

Time period	$\tilde{Z}$(m)	Tw yr.	Part. P loading rate ($G/m^2/q$)	Part. P loading rate ($kg/km^2/day$)	Mean P ug/l	Inflow rate m^3/sec	Outflow rate m^3/sec	Inflow load kg/q	Outflow load kg/q	Accumulation kg/q	R_{Exp}
Jan - Mar '76	7.1	.08	1.86	.200	.070	298.2	273.5	162,881	164,619	1,738	
Apr - Jun	7.1	.10	4.62	.579	.211	292.2	228.8	484,275	129,493	354,782	.74
Jul - Sep	7.1	.19	4.02	.519	.365	146.7	127.4	420,993	285,467	135,526	.32
Oct - Dec	7.1	.22	4.22	.545	.341	164.8	109.8	441,832	213,213	228,619	.52
Jan - Mar '77	7.1	.12	3.83	.6419	.340	194.6	162.8	520,402	394,212	108,190	.24
Apr - Jun	7.1	.10	5.17	.6648	.307	224.9	185.8	541,896	384,202	157,694	.29
Jul - Sep	7.1	.20	3.53	.4559	.399	117.9	95.5	369,606	244,062	125,544	.34

following information on drainage area, lake size, and flow rates was used to calculate the tabular values:

Drainage area near Station A	6,216 km^2
" " of New River	881
" " of Yellowjacket Creek	907
" " of Wehadkee Creek	906
Total	8,910
Lake area	104,812,000 m^2

85. Chloride ion concentrations in West Point Lake waters were determined in the laboratory by a selective ion probe. The mean chloride ion concentrations for each station and associated sampling depths for each quarter from October 1974 through December 1975 are given in Appendix Table 14.

86. Mean concentrations of chloride ions for each station and associated sampling depths for each quarter from January 1976 through September 1977 are given in Table 23. Observed chloride ion concentrations in West Point Lake waters during this study period ranged from 7.5 to 92.3 mg/l. Variations in concentrations associated with station location on the lake and with time are evident in the tabular means. There was no evidence of a trend toward decreased concentrations from Station A to D, nor in vertical distribution except at Station D during summer stratification. During those periods there appeared to be some increase in chloride ion concentrations in deeper waters.

87. Statistical analysis of the chloride ion concentration data only indicated a significant difference at $P = 0.003$ in concentrations associated with sampling periods.

88. The chloride ion concentrations in Yellowjacket Creek and the main stem of the lake were similar in quantity and variation. Wehadkee Creek chloride ion concentrations, on the other hand, were consistently

Table 23

<u>Mean chloride concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.</u>

Period	Depth m	A	B	C	Station D	F	G	E
					mg/l			
Jan-	0	26.5	33.0	29.0	29.0	22.0	28.5	37.0
Mar	2		32.5	30.5	29.0	21.0	29.5	
1976	4		32.0	31.5	28.5	21.5	27.5	
	8		33.0	33.5	34.0			
	12-16		34.5	35.5	34.0			
	24				33.0			
Apr-	0	40.4	38.0	33.6	39.0	29.4	31.1	43.1
Jun	2	38.6	39.8	36.3	36.5	25.1	30.8	
	4		42.5	38.8	30.8	26.1	31.2	
	8		40.8	36.6	34.0			
	12-16		43.6	42.1	33.9			
	24				37.8			
Jul-	0	38.8	41.5	37.8	35.9	36.0	43.1	41.0
Sep	2	43.9	46.5	39.4	37.8	37.0	46.9	
	4		46.9	40.9	40.3	37.0	47.5	
	8		48.6	40.9	33.9			
	12-16		58.6	37.0	36.9			
	24				40.2			
Oct-	0	36.0	43.0	45.5	44.9	35.0	45.2	42.5
Dec	2	39.7	43.7	44.7	47.9	36.2	47.2	
	4		41.0	47.8	42.4	35.1	48.6	
	8		40.5	39.4	43.9			
	12-16		22.9	43.5	49.0			
	24				51.1			
Jan-	0	42.6	43.5	47.1	53.3	32.8	48.8	57.7
Mar	2	45.3	42.6	53.3	53.2	35.5	50.6	
1977	4		45.3	53.3	56.8	37.3	53.3	
	8		46.2	46.2	62.1			
	12-16		31.9	51.5	58.6			
	24				63.9			
Apr-	0	34.8	42.0	44.2	38.5	34.8	54.0	41.0
Jun	2	36.3	43.7	39.7	33.0	35.5	54.7	
	4		39.8	40.8	32.2	36.3	55.1	
	8		41.2	37.9	33.2			
	12-16		32.7	37.1	34.9			
	24				56.5			
Jul-	0	40.80	32.30	37.1	35.9	21.6	32.7	29.3
Sep	2	42.60	34.8	37.4	33.2	21.6	38.1	
	4		32.3	39.0	27.7	31.2	35.5	
	8		33.9	39.7	28.7			
	12-16			41.7	28.4			
	24				27.1			

lower. This might indicate that Wehadkee Creek does not receive any appreciable amount of domestic sewage.

89. Sulfate ion concentrations in West Point Lake waters were determined in the laboratory. The mean sulfate ion concentrations for each station and associated sampling depths for each quarter from January 1976 through September 1977 are given in Table 24. The range observed in concentration of sulfate ion for this period was 0 to 9.0 mg/l.

90. Concentrations of sulfate ions appeared to be positively correlated with turbidity in colder months. During warmer months the concentration entering the lake at Station A was considerably greater than the quantity present in surface waters at Stations C and D. During periods of stratification, the sulfate ion appeared to accumulate in deeper waters. In the tailwaters, concentrations of sulfate ions were generally equal to or less than the mean vertical concentration at Station D.

91. Sulfate ion concentrations in both Wehadkee and Yellowjacket Creek tributaries were generally less than those encountered in the main stem of the lake.

92. Statistical analysis of sulfate ion data indicated that significant differences at $P = 0.0001$ existed between concentrations for stations and for sampling periods.

93. From the data available, the concentration of sulfate ions in West Point Lake waters appeared to be low and was not a significant chemical factor affecting water quality for fish life.

94. Both the soluble Iron (Fe) fraction (that form which passed the 0.45-μ Millipore filter) and the particulate Fe fraction (the portion retained on the 0.45-μ filter) were determined on West Point Lake waters. The mean concentrations of

Table 24

Mean sulfate concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	A	B	C	Station D	F	G	E
					mg/l			
Jan-	0	2.0	3.5	7.5	1.0	2.5	3.5	2.5
Mar	2		4.5	6.0	2.0	3.0	2.5	
1976	4		4.0	5.5	2.5	3.0	3.5	
	8		5.0	6.0	2.5			
	12-16		6.0	7.5	2.0			
	24				1.7			
Apr-	0	3.3	2.3	2.3	2.3	1.5	1.7	2.2
Jun	2	2.3	2.8	2.8	2.3	1.7	1.7	
	4		2.5	2.5	2.5	1.7	1.7	
	8		2.8	2.3	2.4			
	12-16		3.0	2.6	2.3			
	24				1.8			
Jul-	0	4.2	4.0	2.7	2.0	1.0	1.0	2.0
Sep	2	3.5	3.2	2.5	2.0	1.5	1.4	
	4		4.3	2.5	1.5	1.5	1.3	
	8		3.2	2.5	1.5			
	12-16		3.0	2.3	2.3			
	24				6.0			
Oct-	0	3.0	2.5	2.3	1.5	0.6	1.1	1.1
Dec	2	2.8	2.5	2.0	1.3	0.8	1.1	
	4		2.5	1.8	1.5	0.6	1.1	
	8		2.5	2.0	1.5			
	12-16		3.0	2.3	2.0			
	24				1.6			
Jan-	0	3.3	3.8	3.3	3.0	1.5	0.8	2.3
Mar	2	4.0	4.0	2.3	3.8	1.8	0.5	
1977	4		4.0	3.5	3.5	1.0	0.5	
	8		3.8	2.5	3.5			
	12-16		3.5	2.0	3.0			
	24				3.0			
Apr-	0	1.7	1.5	0.5	1.5	1.0	2.0	2.0
Jun	2	1.0	3.0	1.5	1.0	1.5	2.0	
	4		2.0	1.5	0.5	1.0	2.0	
	8		3.0	1.5	0			
	12-16		2.0	1.0	1.2			
	24				4.0			
Jul-	0	5.0	4.0	1.0	1.0	0	0	3.0
Sep	2	5.0	1.5	1.0	1.5	0	0	
	4		1.0	1.0	2.0	1.0	0	
	8		1.0	1.0	2.5			
	12-16			3.5	7.0			
	24				3.0			

Fe for each station and associated sampling depths for each quarter from July 1976 through September 1977 are given in Tables 25 (soluble Fe) and 26 (particulate Fe).

95. Initially it was planned to determine Fe concentrations in West Point Lake waters only for those months when stratification was evident. Since the colloidal clays in this drainage area contained considerable Fe, analyses of suspended matter during periods of high rates of flow were made for comparative purposes.

96. The patterns of both soluble and particulate Fe concentrations in West Point Lake waters for each quarter included in the study are shown in Figure 9. As would be anticipated, the quantity of both soluble and particulate Fe accumulated in the deeper, oxygen-depleted waters during periods of stratification. During the colder months, when D.O. concentrations were more or less homogenous in the vertical water column, soluble Fe concentrations were low, but particulate Fe concentrations remained high from surface to bottom. During this colder period particulate Fe concentrations were generally greater at Station A than at Station D.

97. Tailwater Fe concentrations during stratification were generally less than those present in the deeper waters at Station D indicating that withdrawal through the turbines was a mixture of surface and bottom waters.

98. During warm months Fe concentrations in the upper 4 m of creek waters often indicated a higher concentration of the soluble fraction near the surface than was evident on the main stem of the lake. During colder periods, soluble Fe concentrations in creek tributaries decreased and approached those found at main stem stations.

Table 25

Mean soluble Fe concentration in filtered waters from West Point Lake at indicated stations and depths for quarterly periods when stratification could exist.

Period	Depth m	Stations mg/l A	B	C	D	F	G	E
Jul-	0	0.124	0.233	0.233	0.060	0.125	0	1.307
Sep	2	0.063	0.358	0	0.325	0.125	0.030	
1976	4		0	0	0.030	0	0.280	
	8		0.124	0	0.187			
	12-16		0.060	5.232	2.477			
	24				9.949			
Oct-	0	0.007	0.020	0	0.020	0.010	0.007	0.010
Dec	2	0.013	0.007	0.003	0	0.007	0.008	
	4		0.002	0.005	0.003	0.003	0.010	
	8		0.003	0.010	0.010			
	12-16		0.005	0.005	0.005			
	24				0.005			
Jan-	0							
Mar	2							
1977	4							
	8							
	12-16							
	24							
Apr-	0	0	0	0	0	0.133	0.330	0.475
Jun	2	0	0	0	0	0.113	0.018	
	4		0.018	0.250	0.038	0.018	0.018	
	8		0.330	0.058	0			
	12-16			0	0.017			
	24				0.075			
Jul-	0	0	0.010	0	0	0.043	0.088	0.043
Sep	2	0		0	0.020	0.020	0	
	4		0	0	0	0.075	0	
	8		0.010	0.032	0			
	12-16			0.328	1.690			
	24				3.455			

Table 26

Mean particulate Fe concentrations in waters from West Point Lake at indicated stations and depths for quarterly periods when stratification could exist.

Period	Depth m	Station mg/l A	B	C	D	F	G	E
Jul-	0	1.761	0.335	0.313	0.132	0.323	0.131	1.568
Sep	2	1.492	0.393	0.259	0.185	0.307	0.154	
1976	4		0.276	0.142	0.096	0.279	0.181	
	8		0.806	0.227	0.154			
	12-16		2.257	0.780	1.957			
	24				7.000			
Oct-	0	2.758	1.499	0.525	0.114	1.250	0.528	0.604
Dec	2	2.955	1.640	0.456	0.198	1.290	0.673	
	4		1.763	0.484	0.285	1.436	0.519	
	8		1.362	0.544	0.188			
	12-16		0.655	0.753	0.345			
	24				0.512			
Jan-	0	4.950	2.950	1.007	1.060	1.350	1.537	1.584
Mar	2	4.200	3.100	1.340	1.458	2.191	1.468	
1977	4		2.700	1.322	1.092	2.332	1.452	
	8		2.875	1.215	1.406			
	12-16		2.000	1.260	1.230			
	24				2.420			
Apr-	0	2.880	1.551	0.266	0.207	0.288	0.203	0.240
Jun	2	3.022	1.074	0.320	0.235	0.287	0.244	
	4		1.596	0.292	0.175	0.290	0.209	
	8		2.337	0.221	0.182			
	12-16			0.995	0.560			
	24				2.426			
Jul-	0	1.060	0.039	0.032	0.015	0.348	0.230	0.071
Sep	2	1.015	0.039	0.023	0.052	0.436	0.165	
	4		0.074	0.022	0.079	0.313	0.241	
	8		0.420	0.185	0.079			
	12-16			1.350	6.550			
	24				6.400			

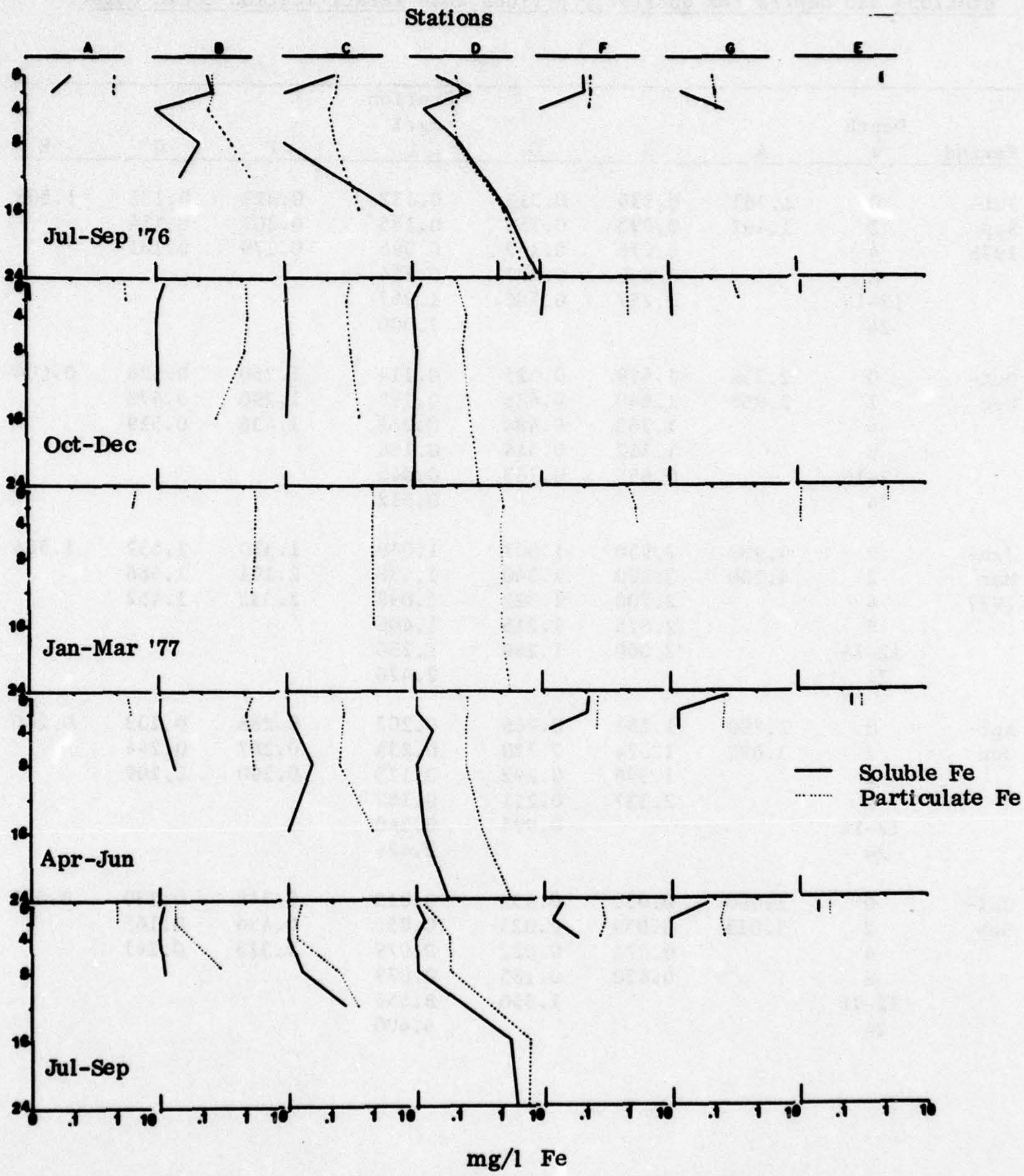

Figure 9. Mean concentrations of soluble and particulate Fe forms in West Point Lake waters at indicated stations and depths for each quarter from July 1976 through September 1977.

99. Both the soluble Manganese (Mn) fraction (that form which passed the 0.45-μ Millipore filter) and the particulate Mn fraction (that portion retained on 0.45-μ filter) were determined on West Point Lake waters. The mean concentrations of Mn for each station and associated sampling depths for each quarter from July 1976 through September 1977 are given in Tables 27 (soluble Mn) and 28 (particulate Mn).

100. Concentrations of soluble Mn in West Point Lake waters were variable during both summers included in this study. In 1976 the concentrations throughout the lake were greater than in 1977. Also, the inflowing waters at Station A and the surface waters in both creek tributaries had greater than normal concentrations of soluble Mn. There was some evidence of a buildup in soluble Mn concentrations in deeper waters during stratification, but it did not approach the magnitude or consistency that was evident for soluble Fe. Tailwater soluble Mn concentrations were greater in 1976 than in 1977.

101. Concentrations of particulate Mn were considerably greater than the soluble fraction throughout the lake during both summers. Tailwater values for each fraction were about equal in 1976, but particulate Mn concentration was slightly greater than the soluble fraction in 1977.

102. There was no evident relationship between particulate Mn concentration and stratification. Rather, the relationship seemingly was associated with quantity of particulate Mn in inflowing waters at Station A and the density current flow pattern at downstream stations. This condition appeared to be evident both summers. Particulate Mn concentrations in surface waters (0- to 4-m depths) of tributary creeks were also greater than anticipated and sometimes exceeded those encountered in Stations C and D on the main stem of the lake.

Table 27

Mean soluble Mn concentration in filtered water from West Point Lake at indicated stations and depths for quarterly periods when stratification could exist.

Period	Depth m	Stations mg/l A	B	C	D	F	G	E
Jul-	0	0.015	0.170	0	0	0.015	0.042	0.072
Sep	2	0.085	0.005	0	0	0.170	0.050	
1976	4		0.082	0	0.005	0.025	0.058	
	8		0.082	0	0			
	12-16		0	0.010	0			
	24				0.735			
Oct-	0	0.028	0.014	0.053	0	0.025	0	0.064
Dec	2	0.064	0.028	0.160	0.057	0.053	0.081	
	4		0	0.039	0.070	0.061	0.025	
	8		0.007	0.025	0.025			
	12-16		0	0	0.120			
	24				0.028			
Jan-	0							
Mar	2							
1977	4							
	8							
	12-16							
	24							
Apr-	0	0	0	0	0	0.003	0	0
Jun	2	0	0	0	0	0.006	0.003	
	4		0	0	0	0.009	0	
	8		0.006	0	0.003			
	12-16			0	0			
	24				0			
Jul-	0	0.013	0	0	0	0	0	0.001
Sep	2	0.001	0	0	0	0	0.008	
	4		0.017	0	0.011	0	0.010	
	8		0.021	0	0.001			
	12-16			0	0.008			
	24				0.006			

Table 28

Mean particulate Mn concentrations in waters from West Point Lake at indicated stations and depths for quarterly sampling periods when stratification could exist.

Period	Depth m	A	B	C	Stations mg/l D	F	G	E
Jul-	0	0.067	0.042	0.044	0.058	0.151	0.052	0.052
Sep	2	0.067	0.082	0.062	0.064	0.171	0.074	
1976	4		0.115	0.048	0.064	0.178	0.095	
	8		0.154	0.303	0.081			
	12-16		0.147	0.099	0.042			
	24				0.072			
Oct-	0	0.604	0.304	0.058	0.063	0.076	0.076	0.074
Dec	2	0.632	0.264	0.058	0.067	0.078	0.092	
	4		0.312	0.072	0.059	0.081	0.087	
	8		0.153	0.068	0.076			
	12-16		0.075	0.081	0.074			
	24				0.084			
Jan-	0							
Mar	2							
1977	4							
	8							
	12-16							
	24							
Apr-	0	0.149	0.191	0.054	0.054	0.085	0.051	0.030
Jun	2	0.156	0.226	0.064	0.053	0.072	0.057	
	4		0.221	0.065	0.041	0.137	0.058	
	8		0.346	0.080	0.091			
	12-16			0.407	0.036			
	24				0.166			
Jul-	0	0.134	0.051	0.042	0.022	0.091	0.043	0.015
Sep	2	0.134	0.046	0.039	0.028	0.099	0.041	
	4		0.084	0.039	0.024	0.086	0.057	
	8		0.147	0.412	0.189			
	12-16			0.040	0.020			
	24				0.024			

103. In general, the Mn data did not consistently indicate the degree of stratification (oxygen depletion) that existed during the summer of 1976 or 1977.

Discussion

104. Selected water quality parameters for West Point Lake from inundation in the fall of 1974 through September 1977 have been presented in tabular and graphic form in the preceding results and the Appendix. Other information gathered on sampling trips, but not recorded in a quantitative manner, will be included in this section.

105. During the first year of impoundment there was considerable organic matter in the form of tree tops, etc., present throughout the lake. This material was manually removed during the summer of 1975. As a result of initial flooding during the colder months of the year, the decomposition of leaf litter and trash during the summer of 1975 produced a considerable quantity of hydrogen sulfide (H_2S) in the deeper, oxygen-depleted areas of the lake and consequently a considerable release of H_2S was evident in the tailwaters and on downstream for some 4 or 5 miles. While the odor of H_2S was evident in muds collected from 3-m depths within the lake, the only evident detrimental effect was a kill of bullhead catfish in shallow water areas. In the tailwaters and on downstream such kills might have occurred, but they were so limited that none were ever observed or reported. During the summer of 1976 production of H_2S in the deeper water areas of the lake was limited and was only noted in September sampling. The same condition existed in 1977. No severe effect of H_2S on fish life was observed during the latter 2 years.

106. Warm weather conditions during the spring of 1975, plus an organically enriched aquatic habitat, promoted the formation of chemically stratified

water conditions by June 1. This condition existed until September 23, 1975, when the lake overturned as a result of hurricane force (75+ mph) winds and rain. During this overturn surface water D.O. concentrations dropped to less than 2 ppm as reported by Georgia Department of Natural Resources personnel. While this condition seemingly existed over a majority of the lake for a short period, only a limited number (very few) of threadfin shad were reported to have been killed.

107. Flushing of the lake by winter and spring rains in 1976 apparently eliminated residual organic materials available in 1975. In 1976, D.O. stratification did not occur until July and persisted until October. While winter and springtime flushing was limited during 1977, the stratification sequence was the same as in 1976.

108. Chemical stratification isopleths were variable with respect to depth and location along the lake stem. In general, the stratification was more pronounced immediately above the dam, but in some instances it occurred some 5 miles upstream. In the tributary creeks the stratification at the 4-m depth was more evident than on the main stem. On numerous sampling dates D.O. concentrations at the 4-m depth were less than 2 ppm. Such conditions were noted on the main stem on rare occasions.

109. D.O. concentrations, while adequate to sustain fish life in surface waters, undoubtedly restrict utilization of deeper waters in summer months by all forms of aquatic animal life.

110. Comparisons of water temperatures for the three summers would tend to indicate that chemical stratification begins to form when surface temperatures approach 20°C and reaches its maximum degree of stratification when surface temperatures approach 30°C. Vertical variations in temperature in waters

deeper than 16 m are about 4°C when the surface is 20°C, and from 6° to 8°C when the surface approaches or exceeds 30°C.

111. Daily flow rates in the Chattahoochee River at Franklin, Georgia, varied within ranges that would completely exchange the water in West Point Lake in 30 to 80 days. Oftentimes the effects of upstream flooding were most evident downstream in the lake in the form of high turbidity. Such instances were more commonplace in winter and spring quarters. The extensive presence of such turbid waters, coupled with rather rapid exchange times, limited phytoplankton production in large areas of the lake. Data obtained by JTU and suspended matter measurements of lake waters in the laboratory indicated that as much as 70 percent of the incoming suspended matter loading was being accumulated as deposits on the lake bottom.

112. The waters in West Point Lake would be classified as very soft (total hardness of less than 20 ppm as $CaCO_3$). Consequently, the pH of these waters would be near or slightly less than 7.0. The major factor affecting pH (excluding the introduction of some pollutant into inflowing streams) would be free CO_2. In surface waters of West Point Lake the free CO_2 concentration normally ranged from <1 to 3 ppm. Such low concentrations exerted limited effects in depressing pH values. Conversely, when the free CO_2 was utilized by phytoplankton in the process of photosynthesis there were limited increases in pH values. All analytical data from the 3 years of study on West Point Lake indicate that phytoplankton was never present in sufficient numbers (except on one occasion) to utilize all of the available free CO_2.

113. Total alkalinity concentrations, expressed as ppm $CaCO_3$, were always less than 50 ppm and generally ranged from 10 to 30 ppm. Surface waters in

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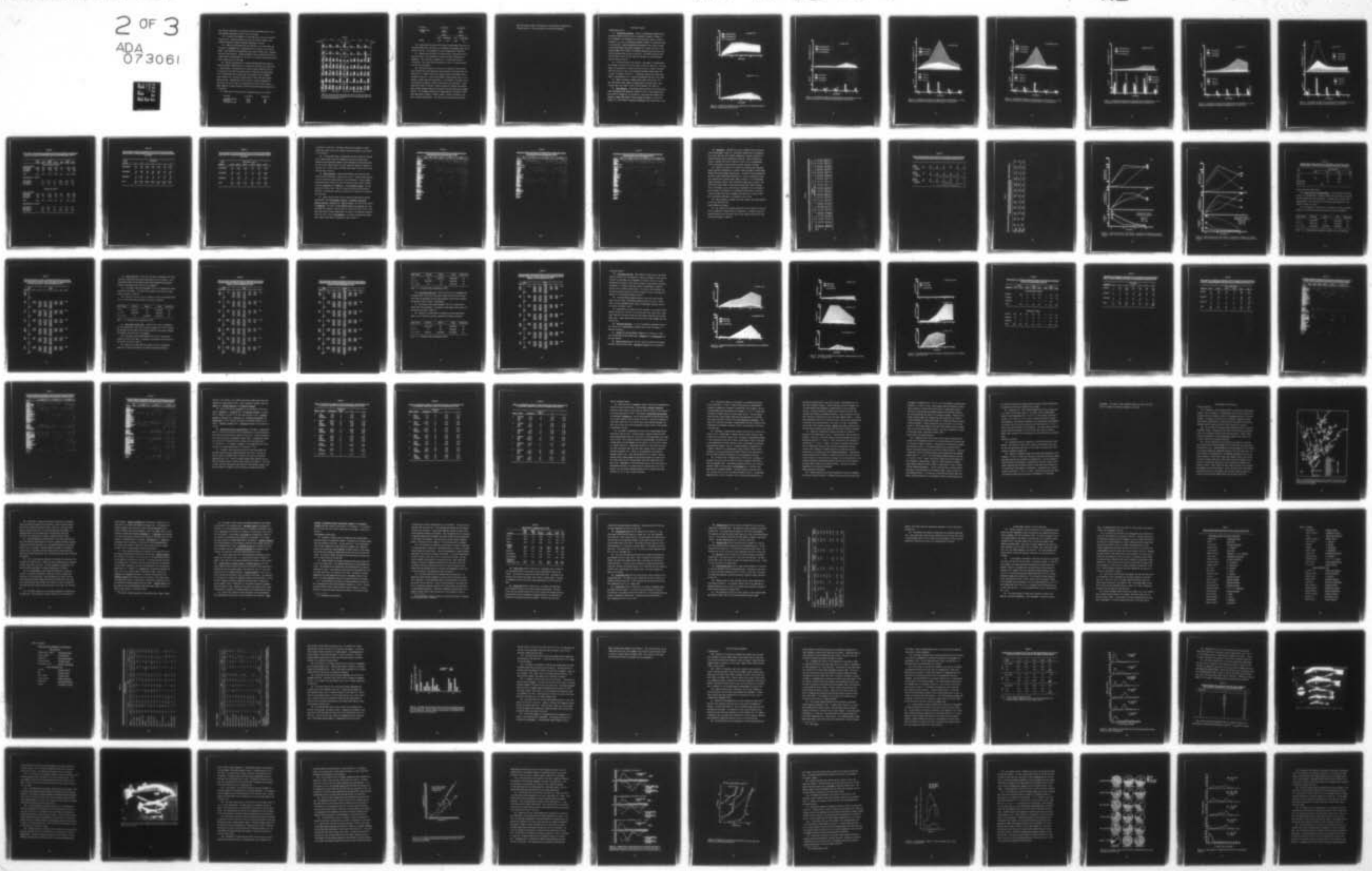

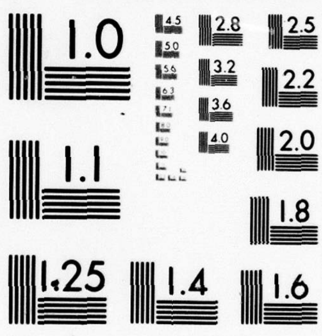

MICROCOPY RESOLUTION TEST CHART

the lake were consistently in the lower range while the deeper waters in the lake sometimes approached the upper limit of the range.

114. As would be anticipated in a soft water lake, sulfate ion concentrations were low. There was evidence that values at Franklin, Georgia, were slightly elevated and gradually decreased downstream to the dam.

115. Chloride ion concentrations were relatively low in lake waters the first year of impoundment but, increased twofold to threefold for the next 20 months. Such variations in concentrations were noted in other rivers in Alabama during this same time span. Present knowledge of factors affecting chloride ion concentrations in surface waters of this area is too limited to attach any significance to these changes at this time.

116. Nutrient concentrations of inflowing Chattahoochee River waters at Franklin, Georgia, ranged from 0.8 to 1.9 ppm N and from 0.05 to 0.27 ppm ortho P. Concentrations in surface waters of tributary creeks ranged from 0.20 to 1.30 ppm N and from 0.022 to 0.132 ppm ortho P. Generally, the concentration of N in Yellowjacket Creek tributary was 0.2 ppm greater than in Wehadkee Creek tributary, but the ortho P concentrations in both creeks were approximately the same. Concentrations of N and ortho P in waters throughout the lake (Figure 10) were in excess of those quantities (0.2 ppm N and 0.02 ppm P) deemed adequate to produce eutrophic conditions (excessive primary productivity) in the waters.

117. Mean annual nutrient export by subdrainage areas was as follows:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Chattahoochee River	125.93	905
New River	40.19	420
Yellowjacket Creek	42.34	434

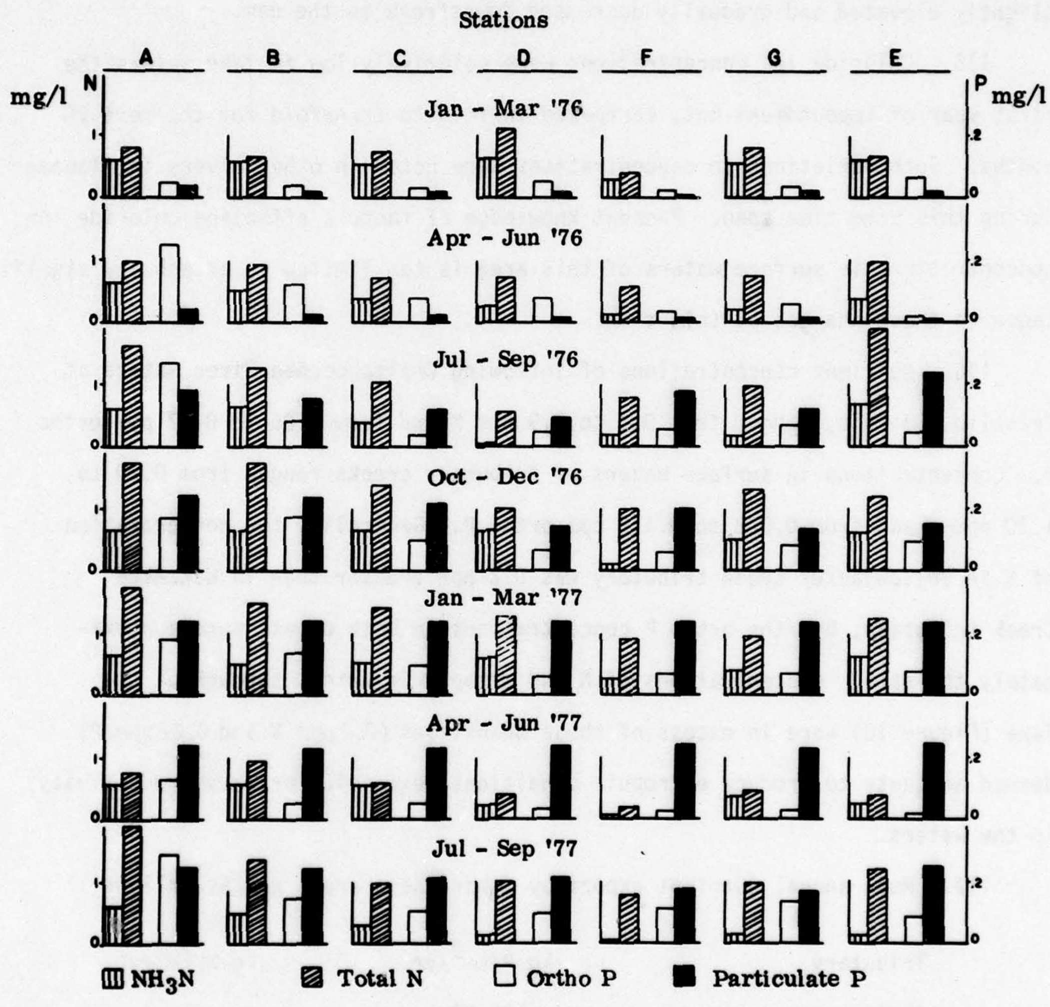

Figure 10. Mean concentrations of NH_3 and total N and ortho and particulate P in West Point Lake waters at indicated stations for each quarter from January 1976 through September 1977.

Tributary	kg P/km^2/yr	kg N/km^2/yr
Wehadkee Creek	36.86	390
Total	245.32	2,149

	Total P		Total N	
	Total	Accumulated	Total	Accumulated
g/m^2/hr	31.06	11.46	182.8	133.1

118. Approximately 65 percent of the ortho P entering West Point Lake via the Chattahoochee River, New River, and Yellowjacket and Wehadkee Creeks was retained in the lake. This amounted to a yearly accumulation of 576,697 kg.

119. Approximately 38 percent of the particulate P entering West Point Lake was retained. This amounted to an additional yearly accumulation of 633,496 kg. Thus, the yearly accumulation of P in West Point Lake was 1,210,193 kg. This latter figure represented an overall 47 percent accumulation rate from inflowing P.

120. Split-plot analysis of variance tests conducted on water quality data indicated that values obtained on most parameters were significantly different (PR > F = 0.0001 in most cases) between stations and between periods, and where stations (B, C, and D) were sampled at depths greater than 4 m, differences in depth values were significant. In the majority of analyses it was indicated that the station × period interaction was also significant. These significant values for stations × periods interactions indicate that measurements (values) between stations did not exhibit the same relationships between periods. This statement concerning the interpretation of interaction significance would apply to depths × stations, depths × periods, and depths × stations × periods relationships. This leads to the conclusion that variables,

other than those included in the analysis of variance model, exerted and influenced upon the "F" values obtained for the measured parameters.

Limnological Studies

Phytoplankton Results

121. Phytoplankton Abundance. Results of phytoplankton enumeration for mainstream sampling stations (A-E) are presented in Figures 11 through 17. For Yellowjacket (G) and Wehadkee (F) Creeks the results appear in Table 29. Chlorophyll a, b, and c concentrations (mg/m^3) accompany all enumerations made in 1976 and 1977. Results obtained with the general linear models procedure indicated that highly significant differences ($P = 0.0001$) occurred in total plankton numbers and in numbers of plankters comprising the three major algal divisions between sampling stations and dates. The Duncan's Multiple Range Test was used to detect specific locations and dates on which differences occurred (Tables 30 and 31).

122. On the mainstream of the reservoir, mean numbers of phytoplankters were highest at Stations B and C and lowest at Station A (Table 30). The large number of phytoplankters at Station B was partly due to a bloom of blue-green algae that occurred in July 1977 and produced estimated organism densities in excess of 26,000/ml (Figure 17). Yellowjacket Creek had the highest mean number of phytoplankters of all stations and Wehadkee Creek one of the lowest.

123. Samples collected in summer months, August 1976 and July 1977, had significantly higher numbers of phytoplankters than other dates. Mean organism counts were lowest in April 1976 and February 1977 (Table 31).

124. Group Dominance. At mainstream sampling stations (A-E) yellow-green algae (Chrysophyta) were numerically dominant on four of eight sampling dates during 1975-77 (Figures 13, 14, 15, and 16). Green algae (Chlorophyta) were dominant in August 1975 (Figure 11) and, except for Station B, in July 1977 (Figure 17). On this date a blue-green (Cyanophyta) algal bloom caused a shift

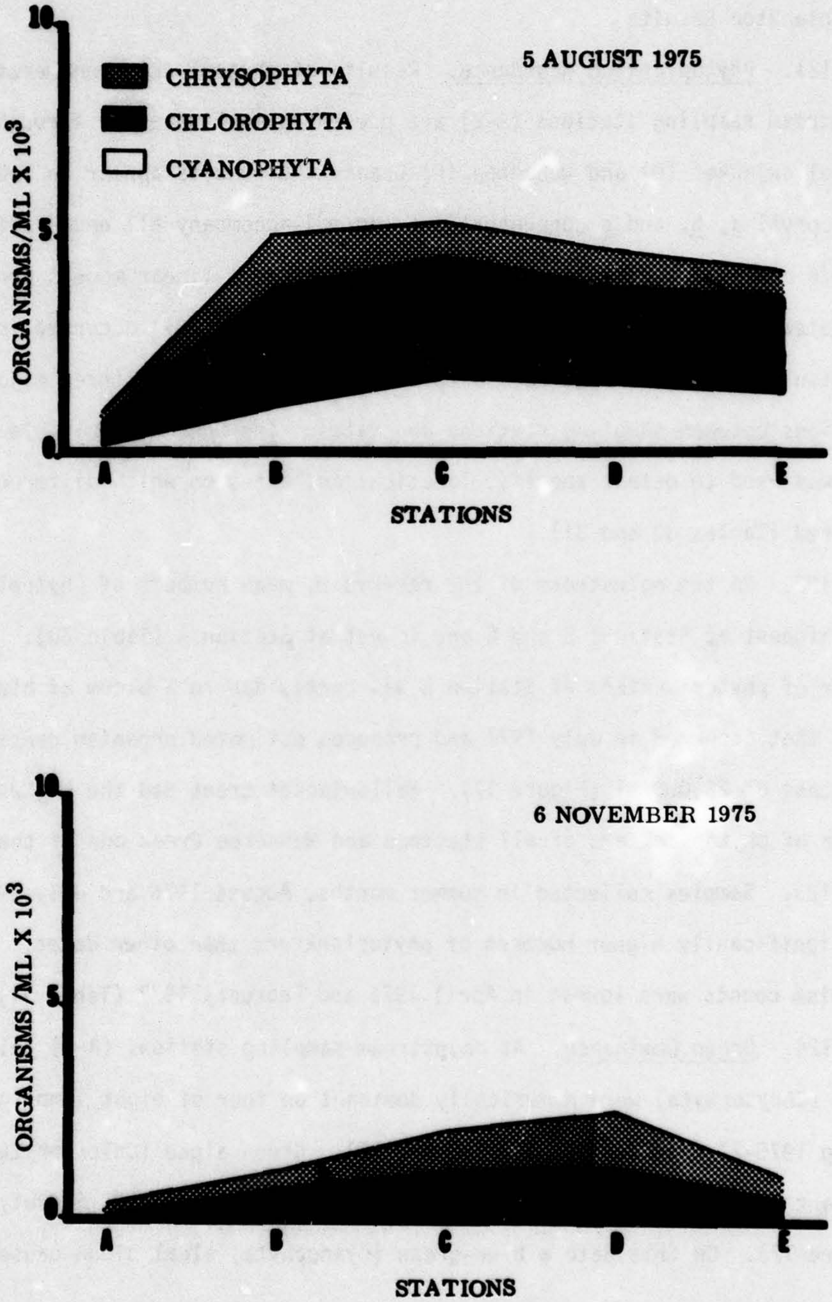

Figure 11. Phytoplankton standing crops (organisms/ml) at mainstream sampling stations on 5 August and 6 November 1975.

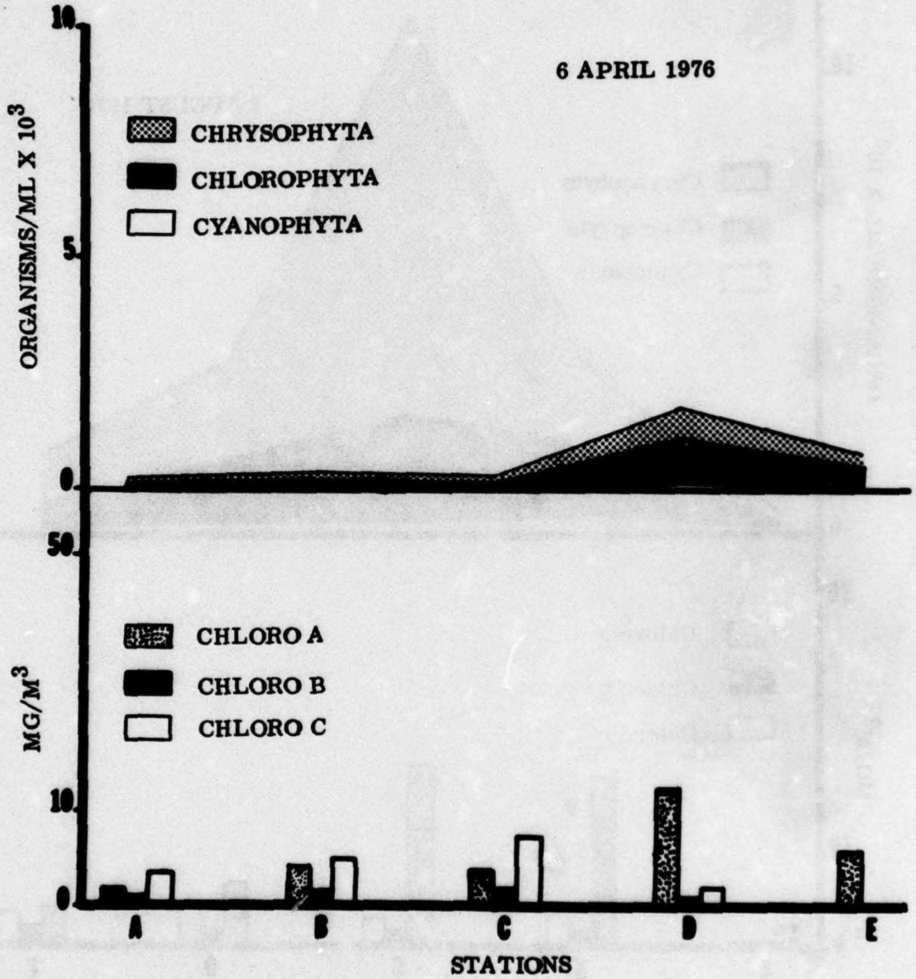

Figure 12. Phytoplankton standing crops (organisms/ml) and chlorophyll a, b, and c concentrations (mg/m^3) at mainstream sampling stations on 6 April 1976.

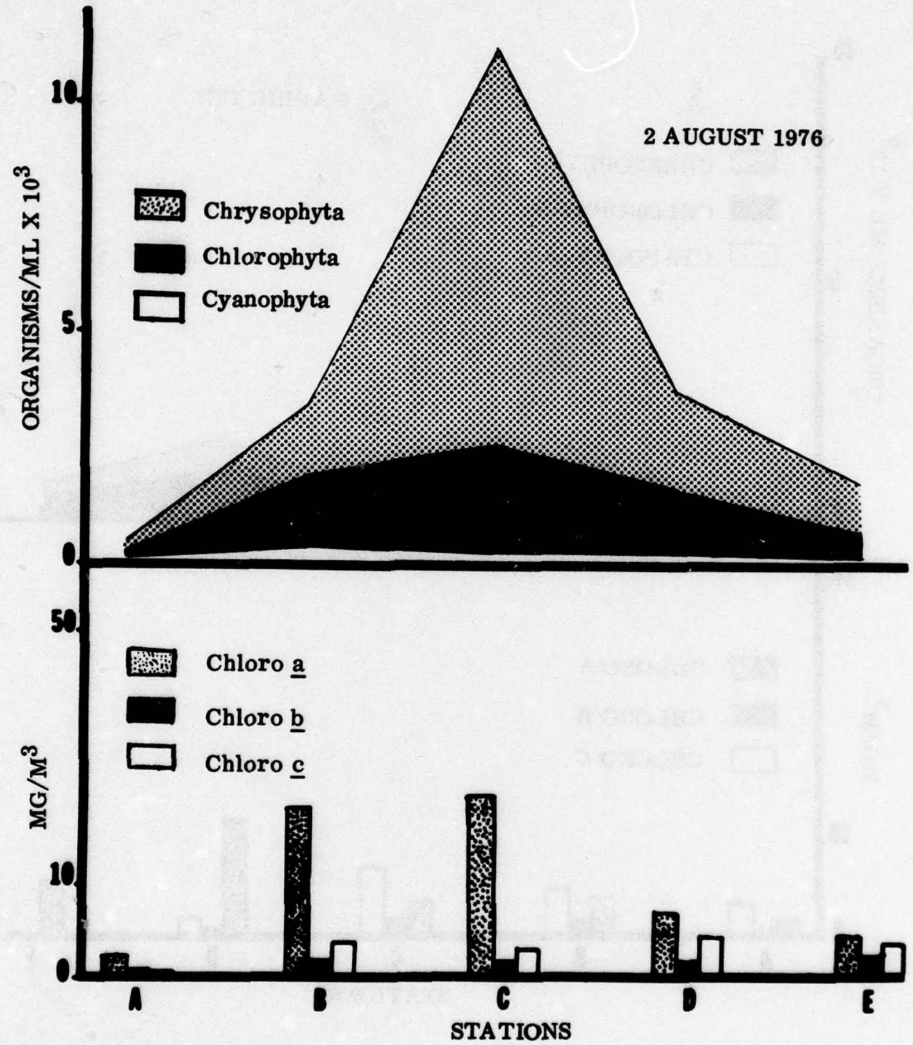

Figure 13. Phytoplankton standing crops (organisms/ml) and chlorophyll a, b, and c concentrations (mg/m^3) at mainstream sampling stations on 2 August 1976.

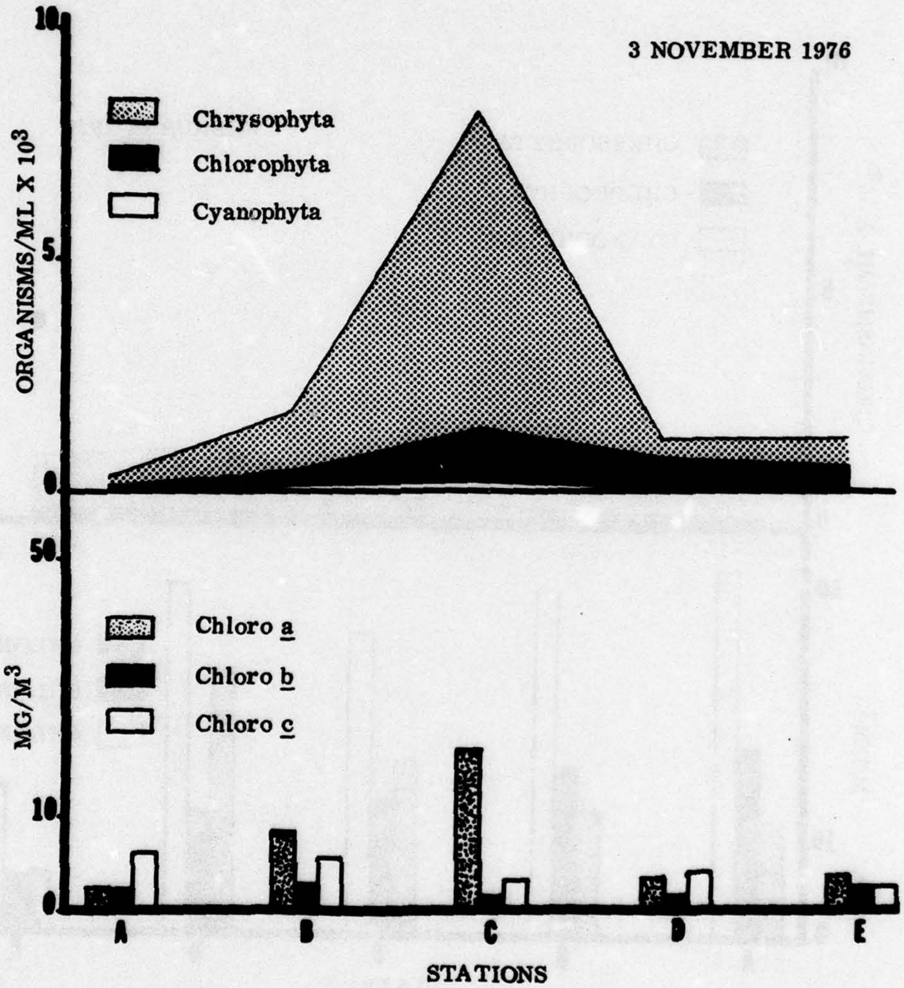

Figure 14. Phytoplankton standing crops (organisms/ml) and chlorophyll a, b, and c concentrations (mg/m^3) at mainstream sampling stations on 3 November 1976.

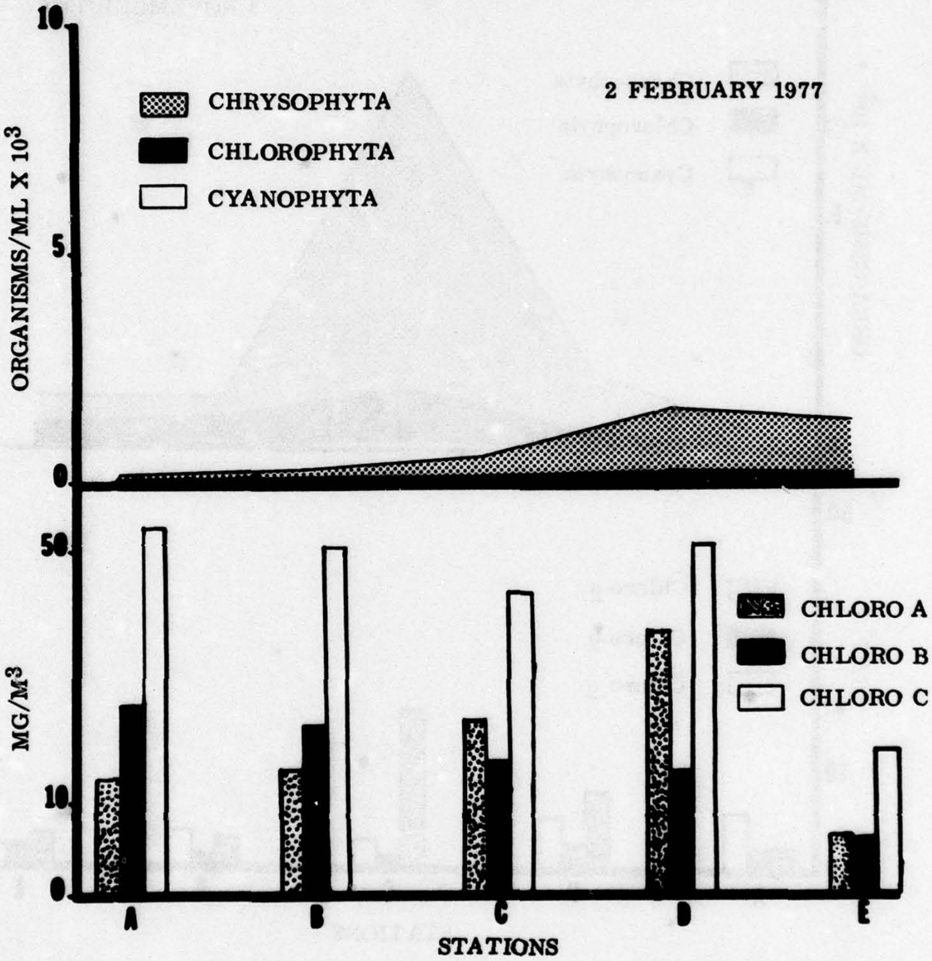

Figure 15. Phytoplankton standing crops (organisms/ml) and chlorophyll a, b, and c concentrations (mg/m^3) at mainstream sampling stations on 2 February 1977.

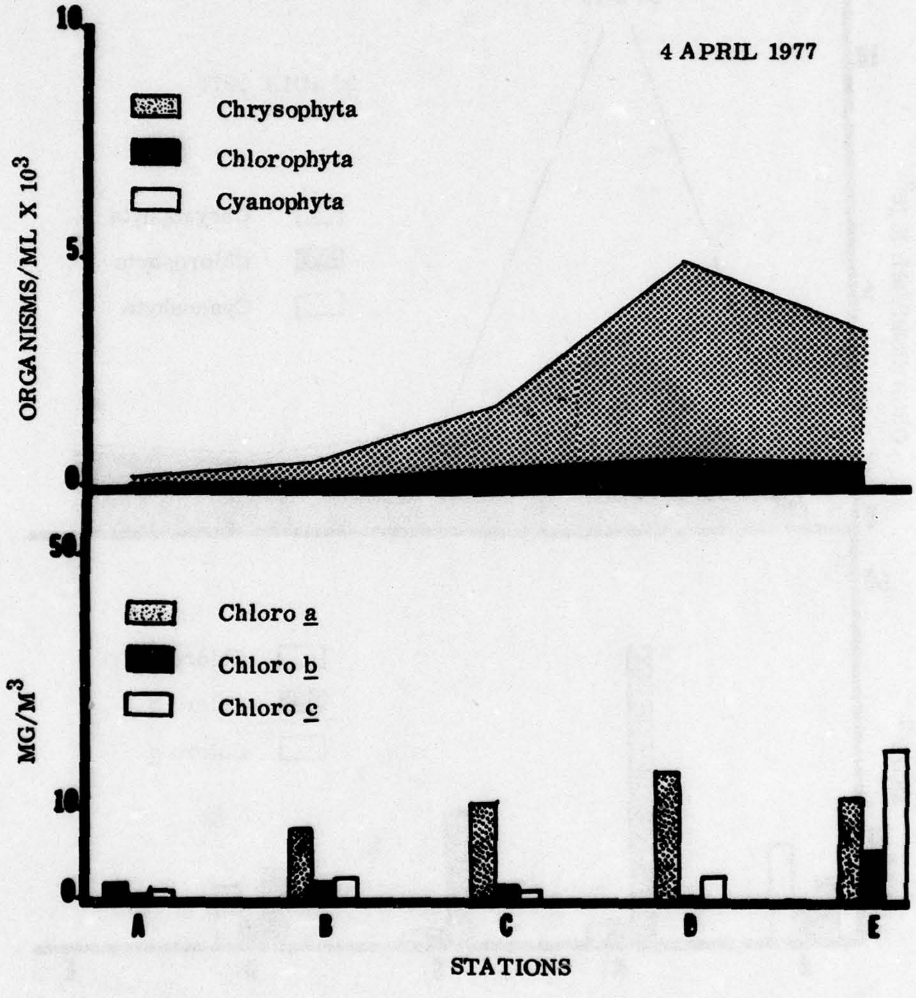

Figure 16. Phytoplankton standing crops (organisms/ml) and chlorophyll a, b, and c concentrations (mg/m^3) at mainstream sampling stations on 4 April 1977.

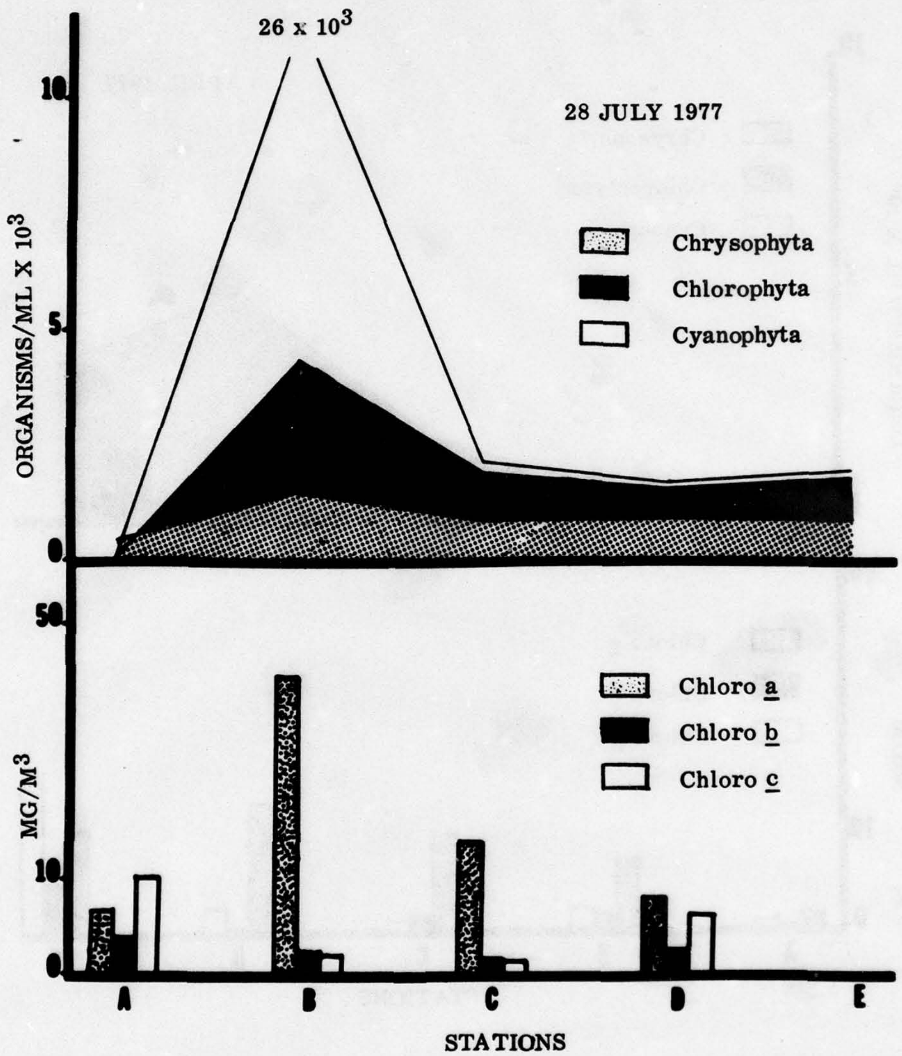

Figure 17. Phytoplankton standing crops (organisms/ml) and chlorophyll a, b, and c concentrations (mg/m^3) at mainstream sampling stations on 28 July 1977.

Table 29

Mean number of phytoplankters (organisms/ml) and mean chlorophyll concentrations (mg/m^3) in Yellowjacket and Wehadkee Creeks on all sampling dates, 1975-77.

	1975	1976			1977		
	Nov.	April	Aug.	Nov.	Feb.	April	July
			YELLOWJACKET CREEK				
ALGAL DIVISION							
Chrysophyta	1,885	422	5,803	2,863	237	1,829	17,187
Chlorophyta	1,227	315	1,626	718	49	434	1,417
Cyanophyta	77	28	84	80	1	34	186
Total	3,190	766	7,514	3,662	288	2,297	18,790
CHLOROPHYLL (mg/m^3)							
Chlorophyll *a*	-	6.6	16.5	8.4	23.6	15.6	30.5
Chlorophyll *b*	-	0.6	2.4	1.8	20.2	7.8	1.1
Chlorophyll *c*	-	4.1	4.8	4.5	61.4	21.8	0.5
			WEHADKEE CREEK				
ALGAL DIVISION							
Chrysophyta	906	164	1,846	800	292	868	1,682
Chlorophyta	991	172	1,335	587	33	273	787
Cyanophyta	100	8	337	54	4	56	201
Total	1,998	346	3,519	1,441	330	1,198	2,670
CHLOROPHYLL (mg/m^3)							
Chlorophyll *a*	-	5.9	12.5	4.2	9.1	9.7	14.8
Chlorophyll *b*	-	3.1	2.6	1.9	6.4	5.9	1.3
Chlorophyll *c*	-	10.1	8.9	3.4	21.7	19.9	0.0

Table 30

Mean phytoplankton numbers (organisms/ml) for each station on all sampling dates in 1976-77. Means subtended by like letters are not significantly different ($p = 0.05$).

Algal Division	STATIONS A	B	C	D	E	F	G
Chrysophyta	201 E	871 D	3,061 B	1,631 C	1,150 D	942 D	4,724 A
Chlorophyta	58 D	832 A	860 A	783 AB	540 CB	532 C	760 AB
Cyanophyta	10 B	3,760 A	115 B	76 B	62 B	110 B	69 B
Total	268 D	5,463 A	4,036 B	2,490 C	1,752 CD	1,584 CD	5,553 A

Table 31

Mean phytoplankton numbers (organisms/ml) for all stations for each sampling date in 1976-77. Means subtended by like letters are not significantly different (p = 0.05).

Algal Division	Date (month - year) Apr-6	Aug-6	Nov-6	Feb-7	Apr-7	Jul-7
Chrysophyta	319 C	3,348 A	2,024 B	551 C	1,775 B	3,627 A
Chlorophyta	352 D	1,451 A	611 C	99 E	360 D	1,151 B
Cyanophyta	34 B	182 B	78 B	7 B	35 B	3,626 A
Total	705 D	4,981 B	2,713 C	656 D	2,170 C	8,403 A

in dominance at Station B. Blue-green algae were more abundant in summer months but, except for this one incident, were never dominant at any location on the reservoir.

125. In Yellowjacket Creek, yellow-green algae were numerically dominant on all sampling dates (Table 29) followed by green and blue-green algae. Wehadkee Creek phytoplankton communities were dominated by yellow-green algae on five of seven sampling dates, and green algae were numerically dominant on the other two. In both creeks, blue-green algae ranked a distant third to the other two algal divisions.

126. Species Dominance. Dominant phytoplankters were ranked by algal divisions and are presented in Tables 32, 33, and 34. Pennate diatoms were not routinely identified to genus because of time limitations. The most commonly encountered pennate diatoms that could be identified without special preparations were *Tabellaria* spp., *Synedra* spp., and *Asterionella formosa*. With the exception of samples taken in May 1975, pennate diatoms occupied prominent positions in the dominance ranking of the majority of stations on all sampling dates and years.

127. Among the other groups the most commonly encountered and abundant phytoplankters were *Ankistrodesmus convolutus*, *Scenedesmus quadricauda*, *Melosira granulata*, *Cyclotella* spp., *Melosira varians*, and various other species of *Scenedesmus*. The centric diatoms *Melosira varians* and *Cyclotella* spp. were more common and abundant on sampling dates in 1976 and 1977 than in 1975. Blue-green algal species seldom ranked higher than fourth in the dominance hierarchy, but in July 1977 a bloom of *Merismopedia* sp. at Station B produced the highest counts (22,145 organisms/ml) encountered to date (Figure 17).

Table 32

Dominance ranking of phytoplankters identified from samples taken at each sampling station on all sampling dates in 1975.

Organism	Date	3-12-75			5-24-75		7-2-75				9-5-75				11-6-75						
	Station	B	C	D	B	C	A	B	D	F	A	B	C	D	A	B	C	D	E	F	G
CHRYSOPHYTA																					
Pennate diatom		3	2	1			2	5	4	2	5	1/7	2	1	1/3/5	2/8	1	1	1	1/3	1
Melosira granulata					1	4	1		7		3				2	6	3	6	2		7
M. varians															6						
Cyclotella sp.						3							5			3		5		5	
Chrysococcus sp.																	6				
Dinobryon sp.																					
Pseudokephyrion undulatum																					
CHLOROPHYTA																					
Ankistrodesmus convolutus			3		4	1	5	1	1			4		5		4	2	3	3	2	4
A. falcatus										1					8						
A. spiralis																					
Scenedesmus sp.								4	3							7					
S. quadricauda						3	7	2			2	2	1		4	5	4	2	4	4	3
S. acuminatus							4					3		2			5	7			
S. armatus											4		2	7						7	
S. denticulatus																	6	4			2
S. bijuga																			5		8
S. dimorphus																					
Pandorina charkowiensis														3							
P. morum		2												8							
Dictyosphaerium sp.																					
Eudorina elegans					3																
Actinastrum hantzschii							3	3					6					5			
Closterium sp.									6		1									8	
Golenkinia sp.								8				5									
Staurastrum sp.									8					4	7						
Crucigenia sp.													7						6		6
Chlamydomonas sp.																1	7				
Pediastrum sp.									5										8		5
P. duplex																					
Coelastrum sp.							8														
Cosmarium sp.																					
Arthrodesmus sp.																					
Sphaerocystis sp.																					
Kirchneriella sp.																					
CYANOPHYTA																					
Anabaena sp.					2																
Gomphosphaeria sp.													4						7		
Merismopedia sp.														6							
Oscillatoria [illegible]								7				6									
Chroococcus sp.												5	8								
EUGLENOPHYTA																					
Trachelomonas sp.																					
Phacus sp.																					
PYRROPHYTA																					
Gymnodinium sp.		1	1	2																	
Peridinium sp.								6	2											6	

Table 33

Dominance ranking of phytoplankters identified from samples taken at each sampling station on all sampling dates in 1976.

Date	4-6-76							8-[illegible]-76							11-[illegible]-76						
Organisms / Station	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G
CHRYSOPHYTA																					
Pennate diatom	1/5	1/6	2/7	4/6	6	3	2			1	1/2	1/2	1/2/4	1/2	1/4	4			2/6	4/5	6
Melosira granulata	2	3	3	3	2	4	4	6					6			5	3	6	5		
M. varians																2	1	5			2
Cyclotella sp.	7	7	6	5	4	6	8	3	2			5		6	3	3	6	6	7		4
Chrysococcus sp.							3		5		5		2								
Dinobryon sp.															2						
Pseudotetraedron neglectum																					
CHLOROPHYTA																					
Ankistrodesmus convolutus	3	2	4	1	1	3	1	2	7	3				3	7	2	5	1	1	1	2
A. falcatus								8								6					
A. nannoselene																					
Scenedesmus sp.								4	6	2						7					
S. quadricauda				7	5	5	7	1	1	6	3	3		4			2	2	2	3	5
S. acuminatus						6											4				
S. armatus	4	4	5		6					7									6		7
S. denticulatus										4				6	8					2	
S. bijuga																					
S. dimorphus																					
Pandorina charkowiensis																					
P. morum												6									
Dictyosphaerium sp.																					
Eudorina elegans																					
Actinastrum hantzschii				8					4	5				7							
Closterium sp.								5	6						6						
Golenkinia sp.											7										
Staurastrum sp.	8	6	8		7	8	6			8	4	8	5						4		3
Crucigenia sp.																		3		7	6
Chlamydomonas sp.	6	5	1	2	3	1					6										
Pediastrum sp.																	7	4			
P. duplex												4									
Coelastrum sp.									3												
Cosmarium sp.														5				7		8	
Arthrodesmus sp.																					
Sphaerocystis sp.													6								
Kirchneriella sp.																					
CYANOPHYTA																					
Anabaena sp.																					
Gomphosphaeria sp.																					
Merismopedia sp.								7			6					5	8				
Oscillatoria angustissima												7									
Chroococcus sp.																					
EUGLENOPHYTA																					
Trachelomonas sp.													7		8						
Phacus sp.																					
PYRROPHYTA																					
Gymnodinium sp.																					
Peridinium sp.							5														

Table 34

Dominance ranking of phytoplankters identified from samples taken at each sampling station on all sampling dates in 1977.

Date	2-8-77							4-27-77							7-28-77						
Organism / Station	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G
CHRYSOPHYTA																					
Pennate diatom	6/3/5	3/3	5/6/8	6	6/7	3/3/4	3/4	1	1	4	2	4	3/5/6	1	1		5	4	3	1	1
Melosira granulata			2	2	2			2	3	3	5	5		6		2	7		5		7
M. varians	5	4	1	1	1		1			2	1	1	2	3	3	7		7	2	3	
Cyclotella sp.		5	4	5	5		6		6	1	3	2	1	2	2			2		3	3
Chrysococcus sp.									2	7					4						6
Dinobryon sp.	7	8		8									7								
[illegible]																					
CHLOROPHYTA																					
Ankistrodesmus convolutus	4			4	3	6	5		4	5	6	3	4	4		4				7	
A. falcatus																					
A. [illegible]	1	1	3	3																	
Scenedesmus sp.		6			8												3		4		
S. quadricauda							6	3		6	4					3	1				4
S. [illegible]																					
S. arcuatus			7													6	8		6		
S. [illegible]											5			5		5	6	5			
S. [illegible]																8					
S. [illegible]									5												
[illegible]																					
P. [illegible]																					
[illegible] sp.													8								
[illegible]																					
Actinastrum hantzschii														7							
Closterium sp.																		8			
[illegible] sp.																					
[illegible] sp.																		3	1	6	6
Crucigenia sp.					4																
Chlamydomonas sp.																	2			8	
[illegible] sp.														8							
P. duplex																					
Coelastrum sp.																		6			5
Cosmarium sp.				7														1	6	4	2
[illegible] sp.						8															
Schroederia sp.																					
Kirchneriella sp.		7																			
CYANOPHYTA																					
Anabaena sp.																					
Oscillatoria sp.								4									4		7	8	
Merismopedia sp.																1					
[illegible]																					
[illegible] sp.																					
EUGLENOPHYTA																					
Trachelomonas sp.						1	3				7										
Euglena sp.							7														
PYRROPHYTA																					
Gymnodinium sp.																					
Peridinium sp.																					

128. Chlorophyll. Chlorophyll *a*, *b*, and *c* standing crops for each station and date appear in Table 35. The highest standing crop of chlorophylls *a*, *b*, and *c*, 348, 250, and 731 mg/m^2, respectively, occurred in February at Station D during a centric diatom bloom (Table 35). Lowest chlorophyll *a* values, 2.5 mg/m^2, were found at Station A in April 1977, and undetectable levels of chlorophyll *b* and *c* occurred at several locations and dates.

129. Results of an analysis of variance test indicated that there were highly significant differences (P = 0.0001) in mean chlorophyll standing crops between stations and between sampling dates. The Duncan's Multiple Range Test was used to detect significant differences (P = 0.05) in chlorophylls at specific stations and on specific dates (Tables 36 and 37). Of the mainstream sampling locations, Station D was significantly higher than all others. Stations B and C were similar in value and had significantly higher standing crops of chlorophyll *a* and *c* than Stations A (headwaters) and E (tailwaters). Mean chlorophyll *a* standing crop in Yellowjacket Creek (Station G) was significantly higher than values in Wehadkee Creek (Station F); however, there were no detectable differences in chlorophyll *b* and *c* values.

130. Mean chlorophyll *a* standing crops were higher on more sampling dates in 1977 than 1976 (Table 37).

Primary Productivity Results

131. Mean values of net primary productivity at each station for 1976 and 1977 are presented in Figures 18 and 19, respectively. Estimates of mean net primary productivity for the entire lake for each sampling period and for combined periods appear in Table 38.

Table 35

Chlorophyll a, b, and c standing crops (mg/m^2) at all sampling stations and on all dates during 1976 and 1977.

		STATIONS																				
		A			B			C			D			E			F			G		
		CHLOROPHYLL (mg/m^2)																				
Year	Month	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
1976	April	3.9	1.4	5.5	26.6	6.4	26.6	6.8	2.6	14.0	25.9	0.4	3.5	5.6	0.0	0.0	12.0	6.2	20.4	13.3	1.2	8.1
	May	3.2	0.2	1.0	56.1	11.3	19.2	84.5	2.9	9.2	48.7	13.3	42.1	4.4	0.3	0.0	33.0	17.7	40.6	52.4	6.3	18.1
	June	6.4	0.2	0.0	41.6	0.5	1.8	68.3	0.7	1.2	47.4	0.5	0.1	4.7	1.1	0.0	7.6	0.1	0.9	17.1	1.3	3.7
	Aug.	3.9	0.8	0.6	82.2	8.1	12.6	83.2	5.9	9.6	51.1	8.7	29.8	4.2	2.1	3.0	51.9	12.2	39.5	71.2	10.6	21.3
	Nov.	4.3	3.4	10.8	31.5	7.6	19.6	76.6	3.1	9.1	26.8	9.3	28.2	3.4	1.8	3.7	16.9	5.9	13.2	16.9	3.7	9.0
	Dec.	5.9	3.0	8.0	37.1	46.4	190.8	51.0	14.6	51.1	266.1	8.2	82.4	35.8	4.4	15.0	27.5	13.3	43.2	26.7	3.3	12.5
1977	Feb.	27.2	46.7	147.7	63.8	84.4	249.3	88.2	66.7	178.3	348.4	250.0	730.8	6.5	6.1	16.1	32.0	21.7	72.5	90.1	72.7	221.0
	March	9.9	7.5	33.0	21.5	21.4	63.7	58.3	30.7	92.2	320.8	100.5	249.7	19.8	4.9	11.1	43.0	24.2	75.4	96.3	37.5	115.6
	April	2.5	1.0	1.7	30.1	6.1	10.3	40.8	6.4	4.8	116.4	2.8	15.0	11.1	5.2	16.6	37.5	22.5	73.0	70.1	30.8	83.6
	June	6.3	3.4	12.6	61.0	5.2	4.5	46.1	10.5	18.3	32.6	6.0	20.0	2.6	1.6	4.5	18.3	8.3	24.9	61.5	10.4	15.0
	July	13.7	7.0	20.4	166.9	9.5	5.6	61.4	6.2	6.5	69.7	22.5	60.8	-	-	-	60.4	5.4	0.0	121.6	3.7	4.1
	Sep.	10.9	2.2	6.9	145.0	16.1	31.8	88.6	14.3	33.8	69.8	12.7	25.8	6.6	1.2	3.2	54.8	7.3	10.6	89.5	7.8	11.2

Table 36

Mean chlorophyll standing crops (mg/m^2) at each station for all sampling dates. Means underlined by a common line are not significantly different ($P=0.05$).

Station	D	B	C	G	F	E	A
Chloro *a* (mg/m^2)	110	64	63	61	33	10	8
Station	D	B	G	C	F	A	E
Chloro *b* (mg/m^2)	34	19	16	14	12	6	3
Station	D	B	G	C	F	A	E
Chloro *c* (mg/m^2)	100	53	44	36	35	21	7

Table 37

Mean chlorophyll standing crops (mg/m^2) on each sampling date for all stations. Means underlined by a common line are not significantly different ($P=0.05$).

Date	Feb-7	Jul-7	Mar-7	Sep-7	Dec-6	Aug-6	Apr-7	May-6	Jun-7	Jun-6	Nov-6	Apr-6
Chloro *a* (mg/m^2)	101	82	82	66	64	50	44	40	33	28	25	14
Date	Feb-7	Mar-7	Dec-6	Apr-7	Jul-7	Sep-7	May-6	Aug-6	Jun-7	Nov-6	Apr-6	Jun-6
Chloro *b* (mg/m^2)	84	32	13	11	9	9	7	7	7	5	3	1
Date	Feb-7	May-7	Dec-6	Apr-7	May-6	Sep-7	Aug-6	Jul-7	Jun-7	Nov-6	Apr-6	Jun-6
Chloro *c* (mg/m^2)	247	92	58	30	19	18	17	16	14	13	12	1

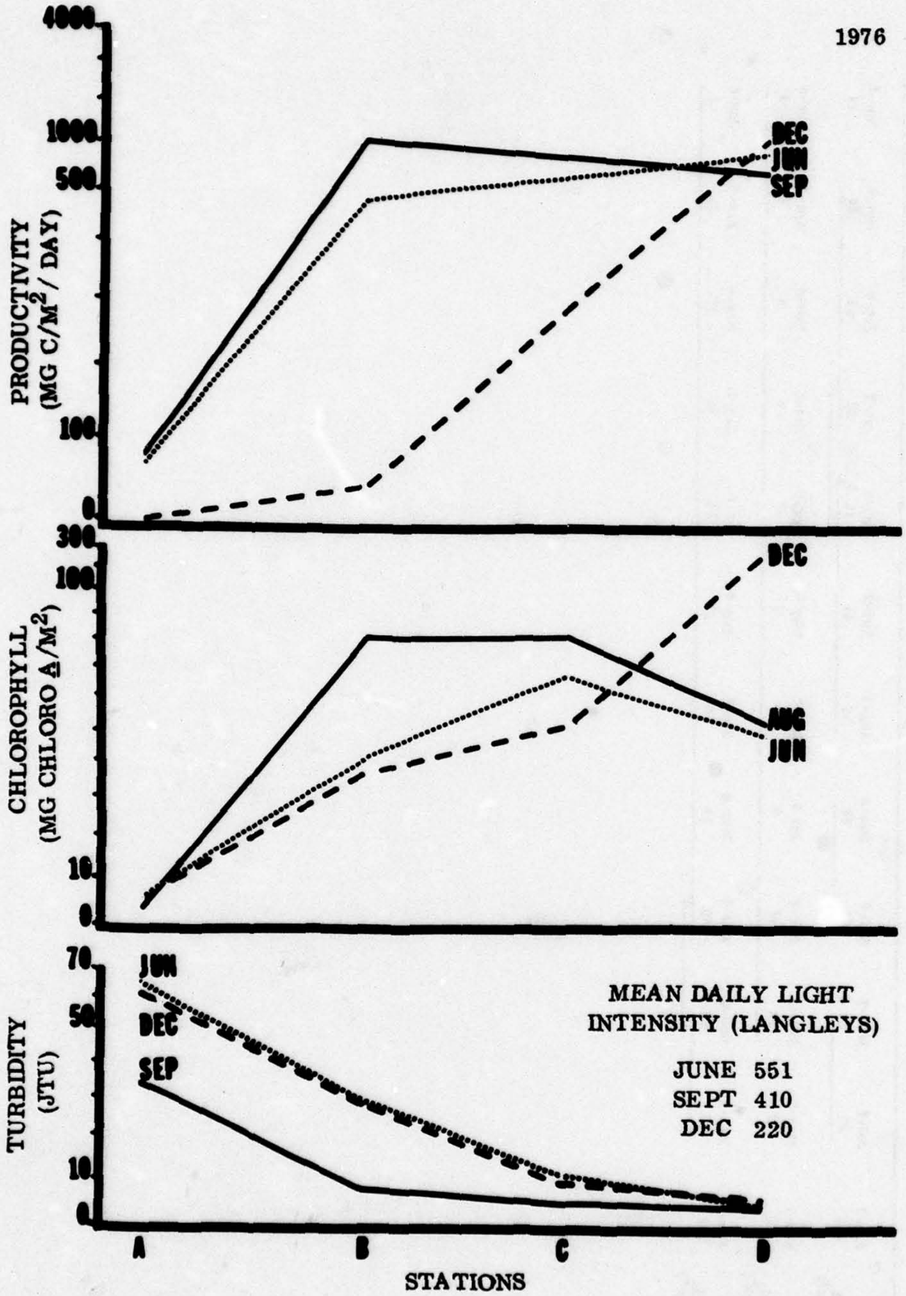

Figure 18. Primary productivity (mg C/m^2/day), chlorophyll a standing crop (mg/m^2), turbidity (JTU), and mean daily light intensity (Langleys) for three sampling periods in 1976.

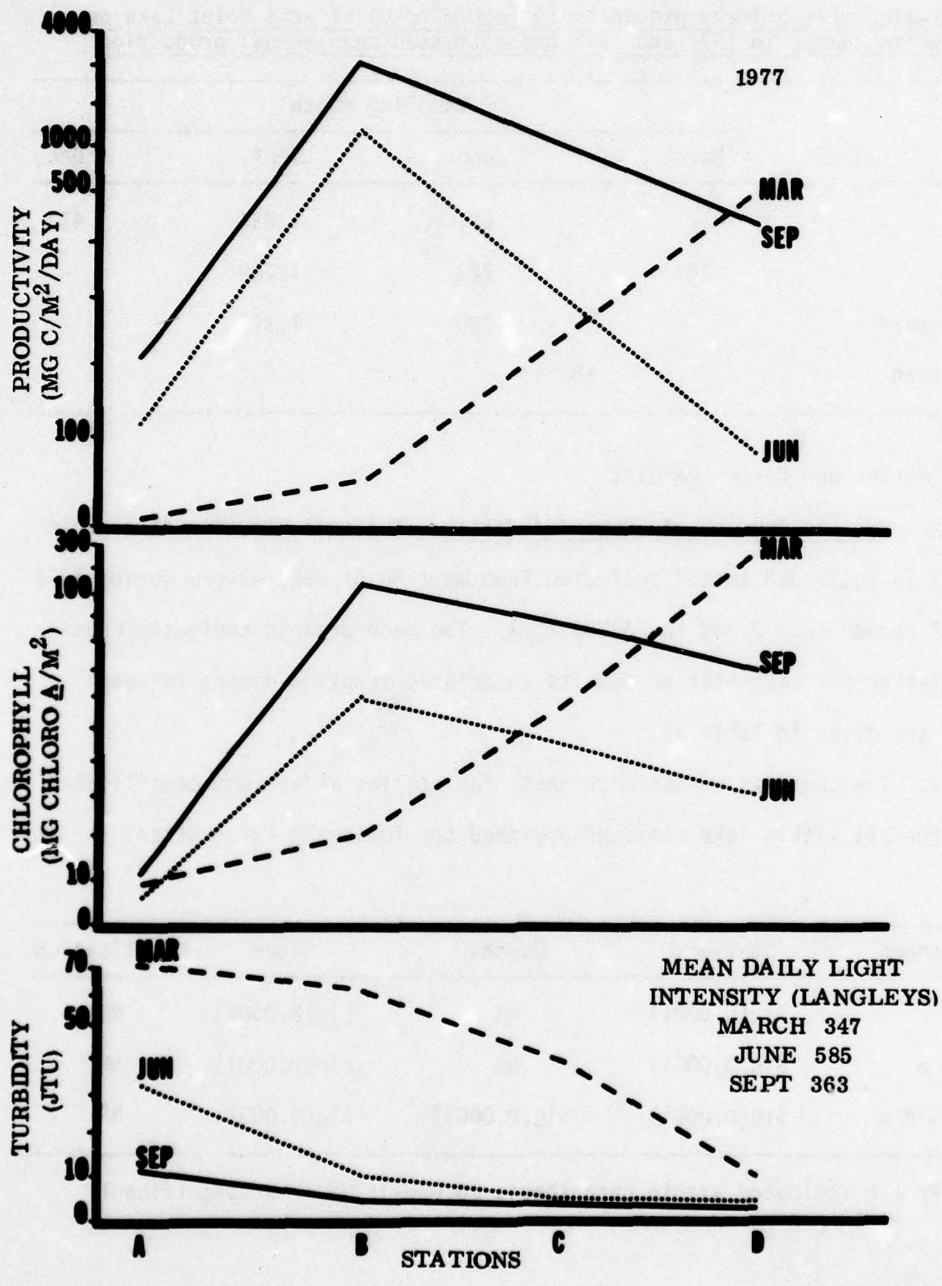

Figure 19. Primary productivity (mg C/m^2/day), chlorophyll a standing crop (mg/m^2), turbidity (JTU), and mean daily light intensity (Langleys) for three sampling periods in 1977.

Table 38

Estimated mean primary productivity ($mgC/m^2/day$) of West Point Lake on sampling dates in 1976 and 1977 and estimated mean annual production

Time	Sampling month			
	March	June	Sept.	Dec.
1976	-	627	834	472
1977	267	773	1,798	-
Monthly mean	-	700	1,316	-
Annual mean	689			

Organic Matter and Carbon Results

132. Organic Content of Suspended Matter. The concentration of organic material in suspended matter collected from West Point Lake waters during 1976 and 1977 ranged from 2.480 to 26.280 mg/l. The mean organic contents of suspended matter for each station and its associated sampling depths for each quarter are given in Table 39.

133. The analysis of variance tests for samples at various consolidated depths for all within-lake stations provided the following information:

Depth ranges	Stations	Depths	Dates	Replication
0- 2 m	Sig(0.0001)	NS	Sig(0.0001)	NS
0- 2- 4 m	Sig(0.0001)	NS	Sig(0.0001)	NS
0- 2- 4- 8 m	Sig(0.0001)	Sig(0.0001)	Sig(0.0001)	NS

Note: Pr > F indicated within parenthesis (0.0001); NS = not significant.

Table 39

Mean organic content, in mg/l, of suspended matter filtered from West Point Lake waters at indicated stations and depths for quarterly sampling periods between April 1, 1976 and September 30, 1977.

Period	Depth m	A	B	C	D	F	G	E
					Station			
Jan-Mar 1976	0							
	2							
	4							
	8							
	12-16							
	24							
Apr-Jun	0	15.925	8.125	6.077	4.333	6.346	3.955	6.328
	2	20.310	8.305	7.015	4.108	3.943	4.397	
	4		8.250	4.660	5.386	4.083	4.063	
	8		9.115	5.697	4.606			
	12-16		13.060	8.230	8.805			
	24				9.086			
Jul-Sep	0	10.360	6.050	5.710	4.077	5.000	5.675	8.060
	2	9.520	6.360	5.017	4.455	5.665	4.740	
	4		5.610	5.402	4.375	5.155	5.396	
	8		11.200	4.660	4.670			
	12-16		10.590	9.890	8.000			
	24				14.250			
Oct-Dec	0	13.375	8.105	4.700	4.280	4.455	4.310	5.650
	2	13.040	7.420	4.565	5.105	4.600	4.470	
	4		7.720	5.125	5.040	5.280	4.540	
	8		7.510	5.945	5.255			
	12-16		4.530	5.775	5.220			
	24				6.340			
Jan-Mar 1977	0	12.600	7.233	5.967	4.460	6.540	4.095	4.205
	2	12.185	6.962	6.275	4.236	5.635	5.460	
	4		7.277	6.275	6.145	5.845	3.570	
	8		7.920	5.840	4.060			
	12-16		3.900	4.520	3.590			
	24				7.440			
Apr-Jun	0	8.580	7.370	4.600	3.470	4.040	3.385	3.970
	2	9.160	8.350	4.780	4.270	3.610	4.240	
	4		6.990	4.650	3.740	3.740	4.120	
	8		8.740	4.610	3.750			
	12-16			6.220	3.780			
	24				7.520			
Jul-Sep	0	24.040	7.920	3.220	3.850	3.560	3.195	4.065
	2	26.240	4.700	2.815	3.065	2.555	3.810	
	4		5.430	3.080	3.200	2.840	3.640	
	8		8.880	5.210	3.515			
	12-16			11.600	6.380			
	24				23.000			

134. Total Carbon (TC). During the first year of impoundment the TC concentration in West Point Lake waters ranged from 4.25 to 18.91 mgC/l. The TC concentration means for each depth at each station sampled for each quarter (October 1974-December 1975) are given in the Appendix.

135. From January 1976 through September 1977 the TC concentration ranged from 5.00 to 16.30 mgC/l. The means for each depth at each station for each quarter are given in Table 40.

136. Analysis of variance tests for samples at various consolidated depths for all within-lake stations provided the following information:

Depth ranges	Stations	Depths	Dates	Replication
0- 2 m	Sig(0.02)	NS	Sig(0.001)	NS
0- 2- 4 m	Sig(0.003)	NS	Sig(0.001)	NS
0- 2- 4- 8 m	NS	Sig(0.001)	Sig(0.001)	NS

Note: Pr > F indicated within parentheses (0.001).

137. Total Organic Carbon (TOC). During the first year of impoundment the TOC concentration in West Point Lake waters ranged from 1.67 to 14.56 mgC/l. The TOC means for each depth at each station sampled for each quarter (October 1974-December 1975) are given in the Appendix.

138. From January 1976 through September 1977 the TOC concentrations ranged from 3.50 to 14.22 mgC/l. The means for each depth at each station for each quarter are given in Table 41.

139. Analysis of variance tests for samples at various consolidated depths for all within-lake stations provided the following information:

Table 40

Mean total carbon concentrations (mg/l) of West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	Station A	B	C	D	F	G	E
Jan-Mar 1976	0	7.95	9.75	10.80	8.15	8.05	9.90	8.50
	2		9.95	10.45	8.15	7.85	9.45	
	4		9.15	10.35	8.95	8.30	9.90	
	8		10.85	11.55	10.05			
	12-16		13.15	11.15	8.60			
	24				8.40			
Apr-Jun	0	8.30	7.45	8.93	8.16	7.60	8.30	7.64
	2	7.76	7.25	8.08	8.08	7.48	8.96	
	4		6.85	8.63	7.70	7.85	7.67	
	8		6.95	8.60	7.41			
	12-16		7.42	7.38	7.96			
	24				10.05			
Jul-Sep	0	8.35	8.12	7.70	7.57	7.87	8.55	8.87
	2	7.72	7.72	8.00	7.85	8.12	7.95	
	4		7.35	8.20	7.47	8.17	8.12	
	8		7.85	7.65	7.45			
	12-16		8.50	11.92	10.60			
	24				14.95			
Oct-Dec	0	10.75	8.35	9.62	9.22	10.32	8.00	10.12
	2	9.32	9.72	8.95	7.20	7.80	8.17	
	4		11.10	10.62	7.25	7.75	8.30	
	8		11.35	10.75	7.30			
	12-16		7.95	9.62	8.05			
	24				9.57			
Jan-Mar 1977	0	10.05	8.92	7.92	8.12	7.27	7.42	8.35
	2	9.00	8.15	7.82	8.32	6.92	7.87	
	4		8.20	7.60	8.17	6.57	7.10	
	8		8.42	7.85	7.77			
	12-16		8.20	7.52	7.85			
	24				8.70			
Apr-Jun	0	6.42	7.20	6.97	7.65	7.37	7.32	7.70
	2	5.52	7.62	7.42	7.40	7.47	7.60	
	4		7.65	7.62	7.37	7.62	7.75	
	8		8.67	6.77	7.37			
	12-16		10.40	8.20	8.15			
	24				10.37			
Jul-Sep	0	12.70	9.70	7.95	7.30	8.60	8.50	10.40
	2	11.25	8.20	7.90	7.55	8.00	8.65	
	4		7.65	7.25	6.90	7.45	8.70	
	8		7.45	9.40	8.30			
	12-16			15.50	14.40			
	24				14.75			

Table 41

Mean total organic carbon concentrations in West Point Lake waters at indicated stations and depths for quarterly periods of sampling between January 1, 1976 and September 30, 1977.

Period	Depth m	A	B	C	Station D	F	G	E
					mg/l			
Jan-	0	6.261	8.270	9.335	6.219	6.223	8.015	6.389
Mar	2		8.425	8.971	6.144	6.053	7.565	
1976	4		7.625	8.856	6.974	6.489	8.000	
	8		9.265	10.026	8.029			
	12-16		11.610	9.622	6.564			
	24				6.349			
Apr-	0	6.334	5.787	7.305	6.557	5.971	6.391	5.653
Jun	2	5.811	5.434	6.385	6.460	5.840	7.018	
	4		4.999	6.812	6.042	5.712	5.781	
	8		4.965	6.626	5.496			
	12-16		5.428	5.215	5.481			
	24				6.674			
Jul-	0	5.941	6.386	5.365	5.589	5.450	6.287	5.078
Sep	2	5.413	5.801	5.776	5.901	5.633	5.717	
	4		5.129	6.014	5.541	5.661	5.855	
	8		5.161	4.662	5.242			
	12-16		6.091	6.527	5.843			
	24				7.686			
Oct-	0	8.370	5.947	7.207	7.105	7.750	5.020	8.013
Dec	2	6.982	7.277	6.607	5.133	5.240	5.203	
	4		8.660	8.267	5.101	5.175	5.268	
	8		8.977	8.415	5.136			
	12-16		5.495	7.237	5.826			
	24				7.381			
Jan-	0	7.822	6.627	5.918	6.439	5.590	5.171	5.176
Mar	2	6.553	5.919	5.677	6.570	5.263	5.673	
1977	4		5.984	5.474	6.444	4.779	4.772	
	8		6.165	5.679	5.888			
	12-16		5.504	5.221	5.755			
	24				6.297			
Apr-	0	4.853	5.075	5.177	6.076	5.764	5.585	4.713
Jun	2	4.013	5.492	5.643	5.796	5.880	5.890	
	4		5.317	5.790	5.832	5.792	5.543	
	8		5.446	4.413	5.319			
	12-16		5.543	5.203	5.282			
	24				6.624			
Jul-	0	9.620	7.945	5.568	5.262	6.205	6.028	6.856
Sep	2	6.985	6.506	5.653	5.452	5.739	6.223	
	4		5.808	4.974	4.906	5.189	6.288	
	8		5.400	5.277	5.190			
	12-16			7.463	7.320			
	24				7.446			

Depth ranges	Stations	Depths	Dates	Replication
0- 2 m	NS	Sig(0.03)	Sig(0.001)	NS
0- 2- 4 m	Sig(0.001)	NS	Sig(0.001)	NS
0- 2- 4- 8m	NS	NS	Sig(0.001)	NS

Note: Pr > F indicated within parentheses (0.001).

140. Particulate Carbon (PC). During the first year of impoundment the PC concentration in West Point Lake waters ranged from 0.232 to 6.621 mgC/l. The PC mean for each depth at each station sampled for each quarter (October 1974-December 1975) are given in the Appendix.

141. From January 1976 through September 1977 the PC concentrations ranged from 0.03 to 8.06 mgC/l. The means for each depth at each station for each quarter are given in Table 42.

142. Analysis of variance tests for samples at various consolidated depths for all within-lake stations provided the following information:

Depth ranges	Stations	Depths	Dates	Replication
0- 2 m	Sig(0.001)	NS	Sig(0.001)	NS
0- 2- 4 m	NS	NS	Sig(0.001)	NS
0- 2- 4- 8 m	Sig(0.02)	Sig(0.001)	Sig(0.001)	NS

Note: Pr > F indicated within parentheses (0.001).

Table 42

Mean particulate carbon concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between January 1, 1976 and September 30, 1977.

Period	Depth m	Station A	B	C	D	F	G	E
					mg/l			
Jan-Mar 1976	0	1.413	2.890	3.136	1.025	1.151	2.018	1.265
	2		1.636	2.836	2.100	1.063	1.516	
	4		2.590	2.072	0.889	1.429	2.048	
	8		2.836	2.672	0.809			
	12-16		3.040	3.900	0.349			
	24				0.523			
Apr-Jun	0	2.513	1.193	1.436	1.236	1.555	1.660	3.118
	2	3.436	1.072	1.276	1.300	1.353	1.445	
	4		1.088	0.814	1.275	1.247	1.167	
	8		1.454	1.613	0.937			
	12-16		1.646	1.554	1.498			
	24				1.814			
Jul-Sep	0	2.157	1.380	1.023	0.926	1.325	1.208	1.806
	2	2.001	1.252	1.110	0.860	1.252	1.210	
	4		1.365	1.086	0.872	1.104	1.161	
	8		1.249	0.830	1.661			
	12-16		1.301	1.929	1.640			
	24				2.795			
Oct-Dec	0	3.227	1.187	1.455	1.140	1.352	1.287	1.417
	2	3.352	1.412	1.045	1.152	1.115	0.667	
	4		0.820	1.077	0.967	1.100	1.142	
	8		1.555	0.997	1.195			
	12-16		1.330	1.217	1.567			
	24				1.310			
Jan-Mar 1977	0	2.647	1.462	1.295	1.315	2.600	1.577	1.537
	2	3.082	1.570	1.400	1.542	2.120	1.632	
	4		1.420	1.137	1.877	2.177	1.190	
	8		1.405	1.002	1.647			
	12-16		0.825	1.315	1.380			
	24				2.220			
Apr-Jun	0	2.741	1.625	1.630	1.527	0.946	1.159	1.226
	2	2.573	1.782	1.824	2.165	1.127	1.225	
	4		2.134	2.114	1.363	1.141	1.081	
	8		2.119	1.117	1.586			
	12-16		2.337	1.627	1.036			
	24				2.444			
Jul-Sep	0	7.101	3.920	1.330	1.200	0.986	1.220	0.880
	2	7.641	2.640	1.120	1.105	1.180	1.350	
	4		2.130	0.935	1.225	1.686	1.165	
	8		2.450	0.850	1.020			
	12-16			4.780	2.360			
	24				4.340			

Zooplankton Results

143. Zooplankton Abundance. Mean numbers of zooplankters at mainstream sampling stations (A-E) are presented in Figures 20 through 22 and at sampling stations on Yellowjacket (G) and Wehadkee (F) Creeks in Table 43. Results obtained with the general linear models procedure revealed highly significant differences ($P = 0.0001$) between mean number of zooplankters at sampling stations and on different sampling dates. The Duncan's Multiple Range Test was used to determine specific locations and dates for which significant differences ($P = 0.05$) existed (Tables 44 and 45).

144. Of the mainstream sampling stations, C and D were significantly higher and A was lower in zooplankton abundance during the study. The two creeks (G and F) supported similar numbers of zooplankters and were statistically equal to Stations C and D.

145. Zooplankters were significantly more abundant in both summer samples (August 1976 and July 1977) and in one spring (April 1977) sample than at other times (Table 45), and each of these was significantly different from all other sample dates. Lowest standing crops occurred in April 1976, November 1976, and February 1977.

146. Zooplankton Dominance. A list of the dominant zooplankters found at each station on all sampling dates from March 1975 to July 1977 appears in Tables 46 through 48.

147. *Cyclops* spp. was the dominant copepod at all stations on all but five occasions during the 29-month study. *Diaptomus* spp. and *Macrocyclops* spp. were also abundant.

148. *Bosmina longirostris* was the most commonly encountered and abundant cladoceran found during the study. *Bosminopsis deitersi* rose to a prominent

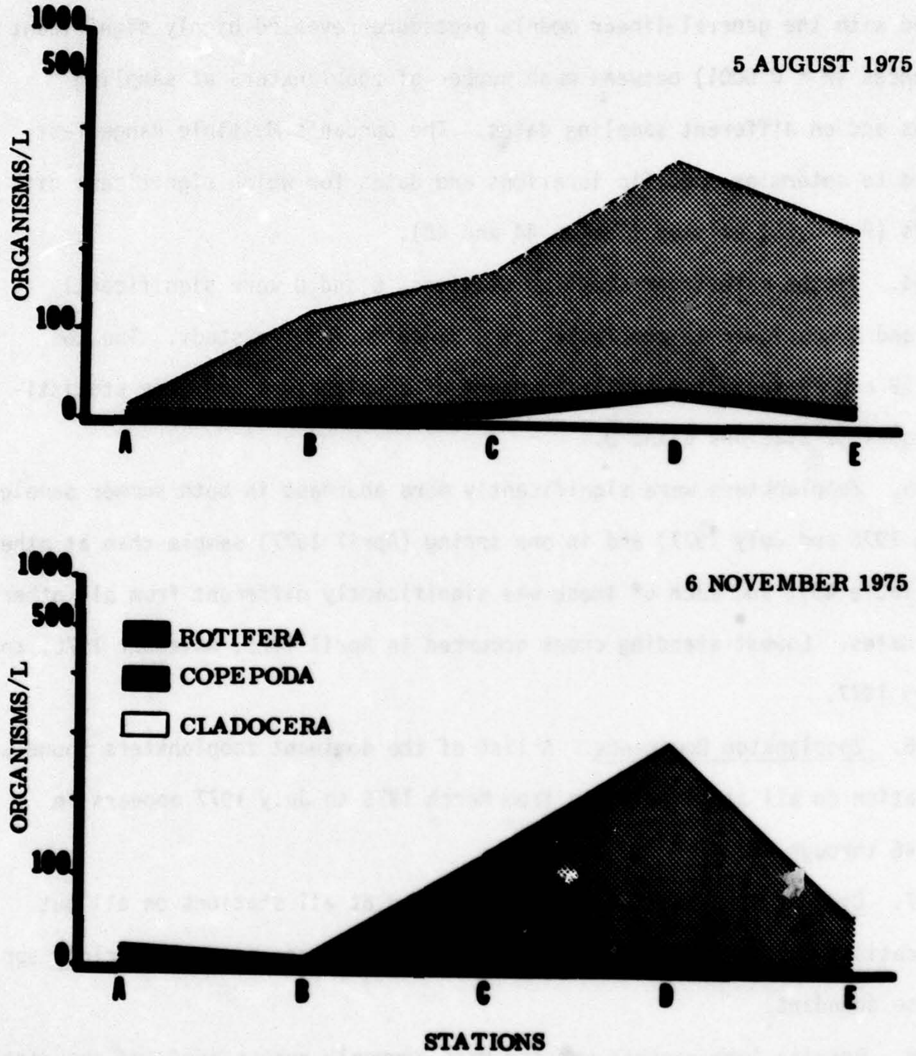

Figure 20. Zooplankton standing crop at mainstream sampling stations on 5 August and 6 November 1975.

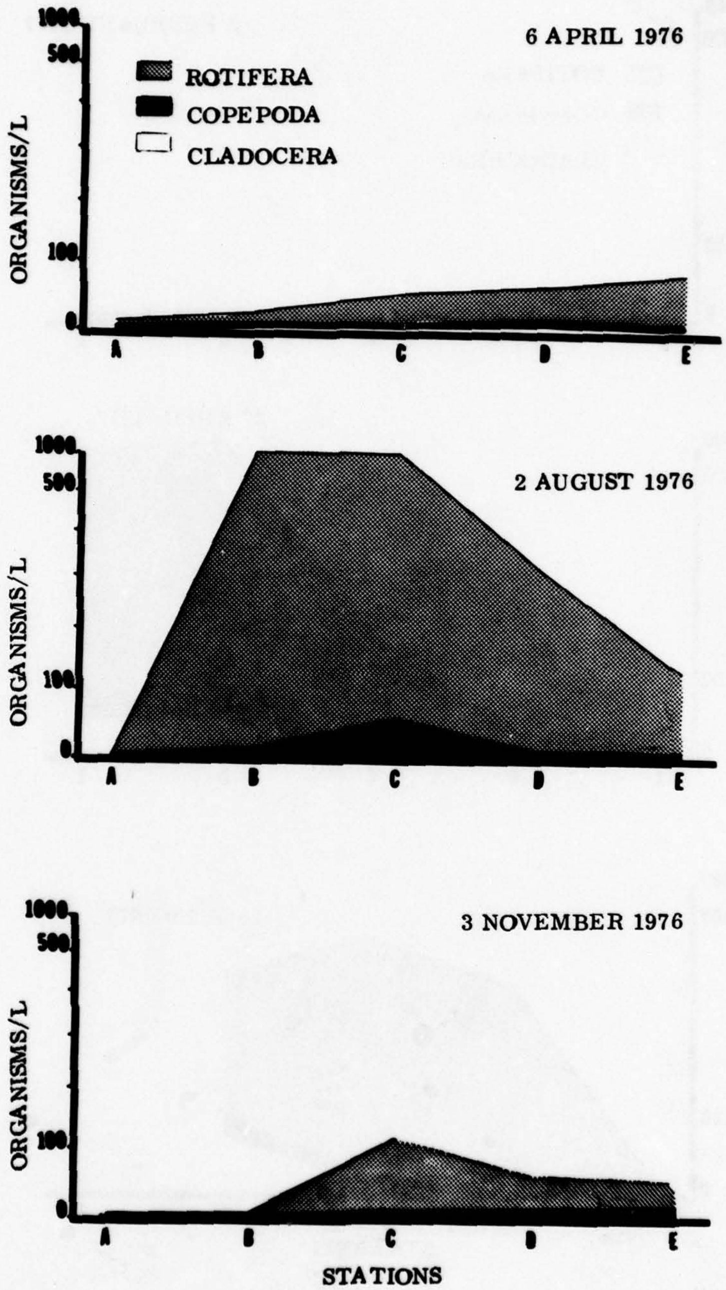

Figure 21. Zooplankton standing crop at mainstream sampling stations on 6 April, 2 August, and 3 November 1976.

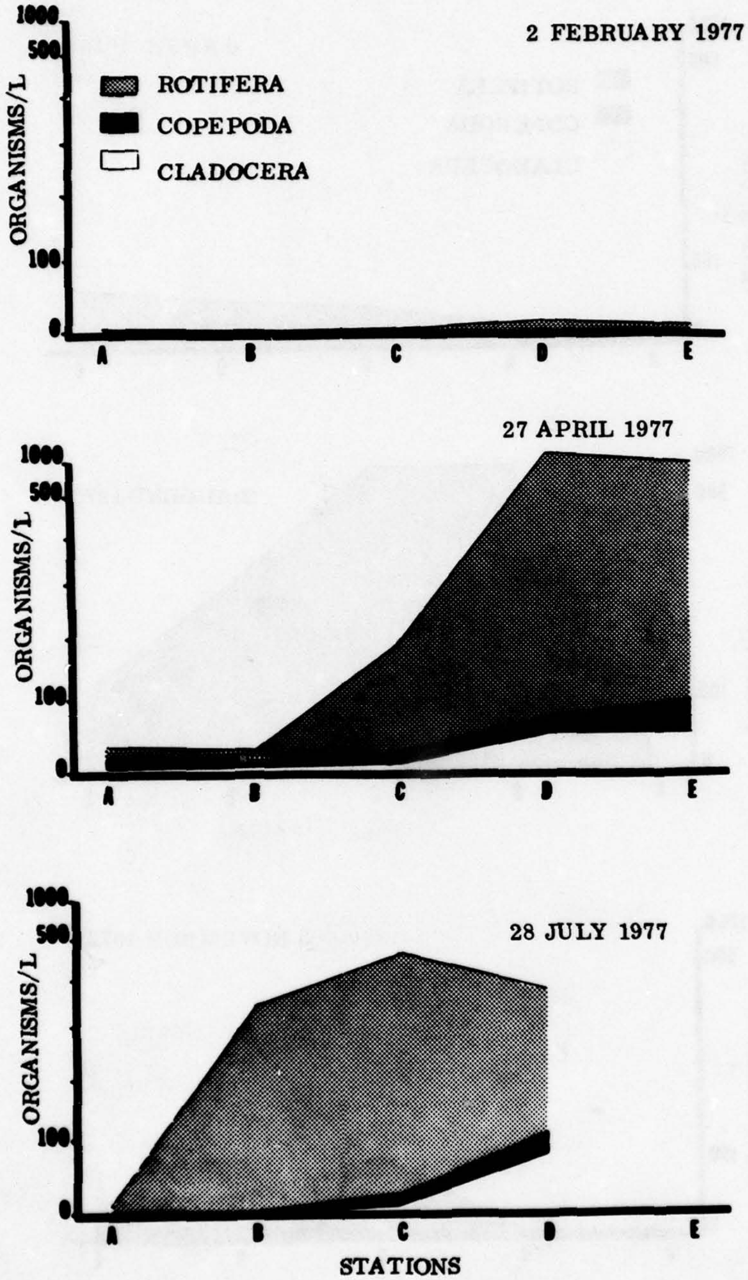

Figure 22. Zooplankton standing crop at mainstream sampling stations on 2 February, 27 April, and 28 July 1977.

Table 43

Mean number of zooplankters (organisms/l) found in Yellowjacket and Wehadkee Creeks on all sampling dates in 1975-77.

	1975		1976			1977		
Organism	Jul	Nov	Apr	Aug	Nov	Feb	Apr	Jul
				YELLOWJACKET CREEK				
Rotifera		202	73	867	138	3	376	193
Copepoda		4	20	33	22	1	26	20
Cladocera		1	5	1	1	0	52	7
Total		207	98	901	161	4	454	220
				WEHADKEE CREEK				
Rotifera	235	102	134	730	177	5	316	472
Copepoda	25	4	12	58	35	1	55	54
Cladocera	0	4	4	13	1	1	27	27
Total	260	110	150	801	213	7	398	553

Table 44

Mean number of zooplankters (organisms/l) for each station on all sampling dates in 1976-77. Means subtended by like letters are not significantly different (P= 0.05).

	STATIONS						
Organisms	A	B	C	D	E	F	G
Rotifera	7 C	245 B	306 AB	337 A	225 B	323 A	275 AB
Copepoda	6 C	7 C	23 B	12 C	17 BC	38 A	20 B
Cladocera	3 B	4 B	6 B	24 A	15 AB	13 B	11 B
Total	16 D	256 C	335 AB	373 A	257 C	374 A	306 ABC

Table 45

Mean number of zooplankters (organisms/l) from all stations for each sampling date in 1976-77. Means subtended by like letters are not significantly different (P=0.05).

	Date (month-year)					
Organism	Apr-6	Aug-6	Nov-6	Feb-7	Apr-7	Jul-7
Rotifera	58	707	80	6	458	299
	DE	A	D	E	B	C
Copepoda	9	30	15	1	26	23
	C	A	C	D	AB	B
Cladocera	5	4	1	1	30	29
	B	B	B	B	A	A
Total	72	741	96	8	514	351
	DE	A	D	E	B	C

Table 46

Dominance ranking of zooplankters found on each sampling date during 1975. Number indicates ranking within each major group, X denotes presence.

Organism (Date / Stations)	3-12-75 B	3-12-75 C	3-12-75 D	5-24-75 B	5-24-75 C	7-2-75 A	7-2-75 B	7-2-75 D	7-2-75 F	8-5-75 A	8-5-75 B	8-5-75 C	8-5-75 D	8-5-75 E	11-6-75 A	11-6-75 B	11-6-75 C	11-6-75 D	11-6-75 E	11-6-75 F	11-6-75 G
ROTIFERA																					
Hexarthra sp.	1	1	1	1	2	3	2	1	1		2	1	1	1	1	1	1	1	1	1	1
Conochilus unicornis		2		3																	3
Keratella serrulata			2	2							3			3			2		2	2	2
Proales sp.					1								3								
Unidentified rotifer					3			3	2												
Synchaeta sp.						1	1	2		1	1	2	2	2		2					
Trichocerca sp.						2					3	3		3				2			
Cyrtonia tuba							3			2											
Trichocerca tetractis									3												
Collotheca sp.									3								3	3		3	
Keratella earlinae										2											
Conochilus hippocrepis																					
Ploesoma sp.																					
Keratella cochlearis																					
Polyarthra sp.																					
Brachionus sp.																					
Kellicottia bostoniensis																					
Asplanchna sp.																					
Conochiloides sp.																					
Lecane sp.																					
COPEPODA																					
Diaptomus sp.	1			1																	
Cyclops sp.	2	1		2	1	1	1	1	1		1	1	1						1	1	
Macrocyclops sp.	3	2			2												1				
Unidentified copepod											2		1				1				
Harpacticoid copepod																					
CLADOCERA																					
Bosmina longirostris	2		1		1		1	1				3	2	2				1	1	1	
Daphnia sp.	3	2																			
Eurycercus lamellatus	1																				
Chydorus sphaericus		1	2																		
Bosminopsis deitersi												1	1	1						3	
Ceriodaphnia pulchella												2	3								
Alona affinis																				2	
Alona sp.																					
Pseudosida bidentata																					
Ilyocryptus sp.																					
Ceriodaphnia sp.																					
Daphnia pulex																					
Holopedium amazonicum																					
Daphnia parvula																					
Alonella sp.																					
Sida crystallina																					
Moina micrura																					
OSTRACODA				X	X		X				X				X						
DIPTERA											X										

Table 47

Dominance ranking of zooplankters found on each sampling date during 1976. Number indicates ranking within each major group, X denotes presence.

	4-6-76							6-2-76							11-3-76						
Organism	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G
ROTIFERA																					
Hexarthra sp.	1	1	1	1	1	1	1	2		3	1	3	2			1	2	1	1	2	
Conochilus unicornis																3	1	2		1	3
Keratella serrulata	2	3	2		2														2		
Proales sp.	3								2											3	
Unidentified rotifer								1			3				1	2		3			
Synchaeta sp.		2	2	3			3		1	2				2	2		3		3		
Trichocerca sp.			3	2	3	3						2		3					2		
Cyrtonia tuba																					
Trichocerca tetractis						2	2														
Collotheca sp.																					
Keratella earlinae																					
Conochilus hippocrepis									3	1			1	1							
Ploesoma sp.											2	1	3								
Keratella cochlearis																					1
Polyarthra sp.																					2
Brachionus sp.																					
Kellicottia bostoniensis																					
Asplanchna sp.																					
Conochiloides sp.																					
Lecane sp.																					
COPEPODA																					
Diaptomus sp.		2	2	2	2	3			3	2								2		2	
Cyclops sp.	1	1	2	2	1	1	1	1	1	1	1		1	1	2	1	1	1	1	1	1
Macrocyclops sp.			1	1		2	2	2							1			3	2		
Unidentified copepod									2												
Harpacticoid copepod																					2
CLADOCERA																					
Bosmina longirostris	1	1	1	1	1	1	1		2	1	1	1	1	1		2	1	1	1	1	1
Daphnia sp.	2			2			3											2			
Eurycercus lamellatus																					
Chydorus sphaericus		2	2	3	2	2	2													2	
Bosminopsis deitersi											2		2	1							
Ceriodaphnia pulchella																					
Alona affinis																					
Alona sp.	2															1			3		
Pseudosida bidentata									1	2			3				1		2		
Ilyocryptus sp.																1				2	
Ceriodaphnia sp.																		3		2	2
Daphnia pulex																					
Holopedium amazonicum																					
Daphnia parvula																					
Alonella sp.										3	3										
Sida crystallina																					2
Moina micrura																					
OSTRACODA		X		X			X						X				X	X		X	X
DIPTERA															X						

Table 48

Dominance ranking of zooplankters found on each sampling date during 1977. Number indicates ranking within each major group, X denotes presence.

Organism	Date / Station	2-2-77 A	B	C	D	E	F	G	4-27-77 A	B	C	D	E	F	G	7-28-77 A	B	C	D	E	F	G
ROTIFERA																						
Hexarthra sp.																						
Conochilus unicornis											1	1	1	1	1							
Keratella serrulata																						
Proales sp.																						
Unidentified rotifer		2	1	3	3		1		2	3					3							
Synchaeta sp.								3		2												
Trichocerca sp.														3				3				
Cyrtonia tuba																						
Trichocerca tetractis																						
Collotheca sp.																						
Keratella earlinae																						
Conochilus hippocrepis																	3	1	1		1	1
Ploesoma sp.																						
Keratella cochlearis		1	3	1	1	2	2	1	3	1	2		3	2		2					3	
Polyarthra sp.									1	3	3	3	2		2				2			
Brachionus sp.		3	2			3											1	2				3
Kellicottia bostoniensis				2	2	1	3	2														
Asplanchna sp.												2					2				2	
Conochiloides sp.																1			3			2
Lecane sp.																3						
COPEPODA																						
Diaptomus sp.									2	2	2	2	2	2	2				2		2	
Cyclops sp.					1	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1
Mesocyclops sp.																						
Unidentified copepod																		2				
Harpacticoid copepod														3								
CLADOCERA																						
Bosmina longirostris		1	1		1		2	1	1	1	1	1	1	1	1		3		3		3	
Daphnia sp.									2		2	2	2	2	2							
Eurycercus lamellatus																						
Chydorus sphaericus									3	2												
Bosminopsis deitersi																		1	1		1	1
Ceriodaphnia pulchella																						
Alona affinis																						
Alona sp.							1															
Pseudosida bidentata											3		3				2		3		3	3
Ilyocryptus sp.																						
Ceriodaphnia sp.											3							3				
Daphnia pulex									3					3								
Holopedium amazonicum												3										
Daphnia parvula															3							
Alonella sp.																						
Sida crystallina																						
Moina micrura																	1	2				2
OSTRACODA											X	X		X	X				X			
DIPTERA		X					X		X					X			X		X			

position in the ranking in most samples taken during summer months when water temperatures ranged between 25-30°C. Other cladocerans frequently found were Daphnia spp., Chydorus sphaericus, and Pseudosida bidentata.

149. During 1975 and 1976, Hexarthra sp. was the dominant rotifer followed by Synchaeta sp., Trichocerca spp., and Keratella serrulata. An abrupt shift in dominance occurred on the three sampling dates in 1977. Keratella cochlearis, Polyarthra spp., Brachionus spp., Kellicottia bostoniensis, and Conochiloides sp. rose, replacing the previously mentioned organisms in the ranking. Conochilus unicornis and C. hippocrepis appeared in large numbers on occasion.

150. Zooplankton Diversity and Equitability. The number of zooplankters, number of taxa, diversity indices ($\bar{d}$), and equitabilities (e) are presented for each sampling station and date in Tables 49, 50, and 51. Diversity and equitability were calculated as recommended by Weber (1973). A hypothetical community consisting of 100 organisms evenly divided into 10 taxa would have a $\bar{d}$ = 3.32 and an e = 1.43, whereas a community of 100 organisms with 90 in one taxa and 10 in another would have a $\bar{d}$ = 0.47 and an e = 0.75.

151. In general, fewer organisms and lower $\bar{d}$'s were found during fall and winter months when water temperatures were 20°C or less. This was particularly obvious in samples taken in February 1977 (Table 51) when water temperatures were $\leq$ 6°C. Station A usually produced fewer organisms and taxa than did stations located in the more lentic areas of the reservoir. The $\bar{d}$ and e values calculated from samples containing few (<100) specimens, however, may be poor estimates of community structure and must be weighed with caution.

Table 49

Number of zooplankters, number of taxa, diversity ($\bar{d}$), and equitability (e) of zooplankton communities by station and sampling date in 1975.

Station	Month	Organisms/l	Number of taxa	$\bar{d}$	e
A	July	43.0	4	1.64	1.00
	August	14.0	4	1.85	1.25
	November	22.0	2	0.51	1.00
B	March	211.0	9	2.35	0.78
	July	199.0	12	2.65	0.75
	August	107.2	9	1.33	0.33
	November	8.0	2	0.98	1.25
C	March	134.0	7	2.29	0.93
	August	146.0	13	2.63	0.69
	November	29.3	5	1.26	0.60
D	March	41.0	5	1.88	1.00
	July	172.5	7	1.89	0.71
	August	95.5	12	2.48	0.67
	November	80.6	8	1.03	0.38
E	August	62.5	8	2.54	1.00
	November	61.0	4	0.90	0.55
F	July	107.0	6	1.32	0.50
	November	31.7	8	1.74	0.50
G	November	76.5	6	1.00	0.42

Table 50

Number of zooplankters, number of taxa, diversity ($\bar{d}$), and equitability (e) of zooplankton communities by station and sampling date in 1976.

Station	Month	Organisms/l	Number of taxa	$\bar{d}$	e
A	April	14.7	8	2.05	0.63
	August	2.0	4	1.86	1.25
	November	6.3	5	1.45	0.65
B	April	26.2	14	2.72	0.64
	August	1,012.5	16	2.11	0.38
	November	7.4	10	2.66	0.85
C	April	64.6	12	2.21	0.50
	August	1,055.1	18	2.10	0.30
	November	114.0	14	2.07	0.39
D	April	43.8	15	2.83	0.67
	August	269.8	14	2.57	0.57
	November	53.2	16	2.35	0.43
E	April	76.8	8	1.20	0.38
	August	87.7	7	2.05	0.78
	November	52.4	11	2.34	0.64
F	April	78.7	16	3.05	0.75
	August	389.3	21	2.81	0.48
	November	114.6	17	2.46	0.44
G	April	84.5	15	2.25	0.47
	August	850.1	15	2.29	0.43
	November	171.6	19	2.54	0.42

Table 51

Number of zooplankters, number of taxa, diversity ($\bar{d}$), and equitability (e) of zooplankton communities by station and sampling date in 1977.

Station	Month	Organisms/l	Number of taxa	$\bar{d}$	e
A	February	6.2	6	2.13	1.00
	April	35.8	16	2.80	0.59
	July	10.6	7	2.47	1.07
B	February	0.4	2	0.81	1.00
	April	32.9	12	2.63	0.71
	July	343.3	17	1.80	0.26
C	February	2.8	3	0.95	1.50
	April	193.3	21	3.12	0.59
	July	468.9	21	2.24	0.31
D	February	16.0	5	0.98	0.50
	April	1,268.5	21	1.74	0.21
	July	370.6	23	2.18	0.26
E	February	14.0	4	1.47	0.88
	April	911.3	17	2.13	0.35
	July	-	-	-	-
F	February	7.2	10	2.98	1.10
	April	401.0	25	2.65	0.36
	July	519.5	21	2.22	0.31
G	February	3.5	6	2.11	1.00
	April	454.2	22	2.47	0.34
	July	220.5	18	2.13	0.33

Aquatic Macrophyte Results

152. After two years of impoundment, aquatic vascular plant development on West Point Lake has been limited. Giant duckweek, Spirodela oligorhiza, occurred in dense stands in the mid-section (Stations B and C) of the reservoir during the summer months of 1975. Alligatorweed, Alternanthera philoxeroides, and smartweeds, Polygonum spp., have colonized marginal and shallow water areas of the upper (Stations A and B) reaches of the lake. The annual fluctuation in water level leaves few, if any, shallow water areas inundated throughout the year, and this may limit future development of aquatic plants in the reservoir.

Phytoplankton Discussion

153. The number of phytoplankters per milliliter ranged between 148 and 26,433 with a mean of 3,272. The Georgia Dept. of Natural Resources (1976) reported phytoplankton densities of from 416 to 10,949 organisms/ml with a mean value of 3,875. Their study was conducted from June-November 1975 and did not include samples from the headwaters of the reservoir in the vicinity of Franklin, Georgia (Station A). Phytoplankton densities in this area of the reservoir were consistently lower than other areas and were similar to densities reported by Schneider et al. (1972) in a preimpoundment study conducted September-February 1970. They reported densities at the Franklin, Georgia, sampling station ranging between 66 and 483 organisms/ml with a mean of 271. This study found densities ranging between 148 and 395 organisms/ml with a mean of 268. Impoundment of the Chattahoochee River has had little effect on phytoplankton densities in the upper more lotic reaches (Station A) of the reservoir, but has greatly increased standing crop in the more lentic areas (Stations B, C, D, G, and F) further downstream.

154. Phytoplankton numbers and chlorophyll a concentrations were positively correlated ($r = 0.49$; $P = 0.0001$) indicating that as phytoplankters increased in numbers the chlorophyll a concentration also increased. The correlation between these two parameters was stronger ($r = 0.91$; $P = 0.0001$) when calculated for samples taken only during summer and fall. This was because winter and early spring plankton algae were often dominated by a relatively few, large-sized centric diatoms of the genera *Melosira* and *Cyclotella*. This results in a relatively low number of phytoplankters yielding a relatively high concentration of chlorophyll a because of their large individual size (Figure 15 and Table 29).

155. Chlorophyll a concentrations (mg/m^3) ranged from 0.71 to 49.69 with a mean of 13.13. Georgia Dept. of Natural Resources (1976) reported a range of from 0.63 to 16.49 with a mean of 9.69. Chlorophyll a concentrations peaked in late winter-early spring, during centric diatom blooms (Figure 15) and again in late summer-early fall when mixtures of green, yellow-green and blue-green algae prevailed (Figures 13 and 17). A mean chlorophyll a concentration of 13 mg/m^3 is indicative of a mesoeutrophic status according to Wetzel (1975). Chlorophyll a, b, and c standing crops (mg/m^2) (Table 35) were calculated primarily to provide baseline information for future comparative reference.

156. On three of the 13 sampling dates in 1976 and 1977, chlorophyll a standing crops from at least one sampling location exceeded 40 mg/m^3 (March, July, and September 1977). Phytoplankton analyses were made in July 1977 and revealed a bloom of the blue-green alga *Merismopedia* sp. at Station B with organism counts exceeding 26,000/ml. This was a period of high solar radiation, low water flow, and low lake elevation (Appendix Table 1). Surface water temperatures were 28.5°C, turbidity 8 JTU's, and nutrient concentrations as

measured at upstream Station A were high (0.35 mg/l orthophosphate and 2.00 mg/l total inorganic nitrogen). Similar conditions existed in September 1977 to produce equally high chlorophyll a concentrations at the same sampling location. The high chlorophyll a standing crop at Station D in March 1977 resulted from different environmental conditions. Solar radiation was low and water flow high in comparison with the July sample (Appendix Table 1). Surface water temperatures were 16.0°C, turbidity 8.5 JTU's, and nutrient concentrations as measured at the upstream Station C were lower at 0.10 mg/l orthophosphate and 1.06 mg/l total inorganic nitrogen. *Melosira* was probably responsible for the March bloom although plankton algae were not sampled in March or September.

157. Apparently, phytoplankton standing crops were not limited by a shortage of the macronutrients, N and P. The most obvious limiting factor was turbidity. There was a significant negative correlation between turbidity and phytoplankton density ($r = -0.30$; $P = 0.001$) and turbidity and chlorophyll a concentration ($r = -0.18$; $P = 0.008$). This inverse relationship would doubtless be stronger were it not for the fact that as phytoplankton densities increase, with a decrease in inorganic particles in suspension, turbidity values begin to rise again due to the suspended phytoplankters. Reduced phytoplankton standing crops at Station D in August 1976 (Figure 13) and at Stations C and D (Figure 17) in July 1977 were not, however, due to high turbidity or low nitrogen or phosphorus concentrations despite the fact that N and P concentrations were usually higher at the upstream stations. The factor or factors responsible for this decline are unknown.

Primary Productivity Discussion

158. Highest productivity for West Point Reservoir occurred in September of both years (Figures 18 and 19). Productivity was positively correlated with

chlorophyll a concentration ($r = 0.57$; $P = 0.01$) and negatively correlated with turbidity ($r = -0.53$; $P = 0.01$). High standing crops of chlorophyll a encountered at Station D in March 1977 did not result in exceptionally high productivity at that location and estimated production for the whole reservoir for the spring quarter was lowest of all quarterly estimates. Results of the Duncan's Multiple Range Test indicated that mean productivity at Station B (1,050 mg C/m^2/day) was significantly higher ($P = 0.05$) than values for Station D (646 mg C/m_2/day). Station D productivity was also higher ($P = 0.05$) than Station A. Annual mean productivity for West Point Reservoir based on samples taken in 1976 and 1977 was 689 mg C/m^2/day. This rate of production is typical of mesotrophic lakes as described by Wetzel (1975).

Organic Matter and Carbon Discussion

159. Suspended organic matter and particulate carbon concentrations decreased from the headwaters (Station A) to the dam (Station D) on the main stem of the reservoir (Tables 39 and 42). Concentrations in Yellowjacket and Wehadkee Creeks were similar. Distribution patterns of total carbon and total organic carbon concentrations were less distinct (Tables 40 and 41). There was a significant inverse relationship between primary productivity and suspended organic matter ($r = -0.55$; $P = 0.01$) and between primary productivity and TOC ($r = -0.43$; $P = 0.05$). Further, there was no significant relation between TOC and chlorophyll a concentrations. Logically, organic carbon and suspended organic matter should be directly related, to some extent at least, to carbon fixation through photosynthesis. The fact that there was an inverse relationship seems to be attributable to allochthonous organic loading primarily via the Chattahoochee River. This resulted in relatively high organic matter and organic carbon concentration in the headwaters (Station A) where productivity

was lowest and relatively low organic matter and organic carbon concentrations at downstream stations where productivity was higher.

160. Schneider et al. (1972) reported summertime TOC values ranging from 2 to 13 mg/l and wintertime values of 1 to 14 mg/l in their preimpoundment studies of the Chattahoochee River. Vick et al. (1976) reported a mean TOC of 4.6 mg/l, with a range of 1.2 to 11.0 mg/l, at Station A (Franklin, Georgia) during sampling. They reported a decrease in TOC concentrations from headwaters to the dam on the main stem of the reservoir with the exception of a rise in values just below Yellowjacket Creek confluence. TOC concentrations during the present study varied between 1.67 and 14.56 mg/l with a mean of 6.02 mg/l. Wetzel (1975) considers TOC values between 5 and 30 mg/l indicative of eutrophic waters.

Zooplankton Discussion

161. Zooplankter densities (organisms/l) in West Point Reservoir ranged between 1 and 1,664 with a mean of 292. Results of zooplankton studies thus far have provided baseline data that will be valuable in measuring any future changes in zooplankton communities.

162. Generally, zooplankton numbers were higher when phytoplankters were abundant ($r = 0.28$; $P = 0.003$), but there was no significant correlation between zooplankton densities and chlorophyll _a_ concentrations. This was probably because relatively high chlorophyll _a_ concentrations in winter and early spring samples resulting from low density stands of large-sized centric diatoms did not coincide with large numbers of zooplankters. Zooplankters were inversely related to turbidity ($r = -0.41$; $P = 0.001$). Conditions prevailing when reservoir waters are turbid are not conducive to phytoplankton or zooplankton

development. The extent to which suspended inorganic particles cause the decline in numbers of planktonic organisms is not known.

Preimpoundment Fish Populations

Species Composition

163. *Impounding* a riverine system results in qualitative and quantitative changes in the fish community. Preimpoundment surveys provide a baseline for discussing faunistic changes and a basis for management decisions in reservoir planning. For example, the presence of a threatened or endangered species would require consideration for preservation while the absence of potentially important reservoir species would permit early planning for stocking.

164. The fish fauna of the upper-middle Chattahoochee River has not been extensively studied. Dahlberg and Scott (1971a, 1971b) discuss the distribution of fish in Georgia within the various drainage basins. Gilbert (1969) collected throughout the central Chattahoochee system but only seven collections were made within the present study area.

165. The major objective of this portion of the study was to describe the distribution and relative abundance of the fishes within the proposed West Point Reservoir basin. Rotenone sampling will be considered only with reference to the species composition; quantitative aspects will be discussed later. The study included the unimpounded basin and immediate watershed of the reservoir from the damsite 3.2 miles north of West Point, Georgia, north to the vicinity of Franklin, Georgia (Figure 23). Water quality has been influenced by agricultural and construction practices as well as effluents from domestic and industrial sources. These factors have most probably affected the distribution and abundance of certain fish species. During the study period the Chattahoochee River carried a very high organic load, but most tributaries were less altered by these conditions (Georgia Water Quality Control Board 1971).

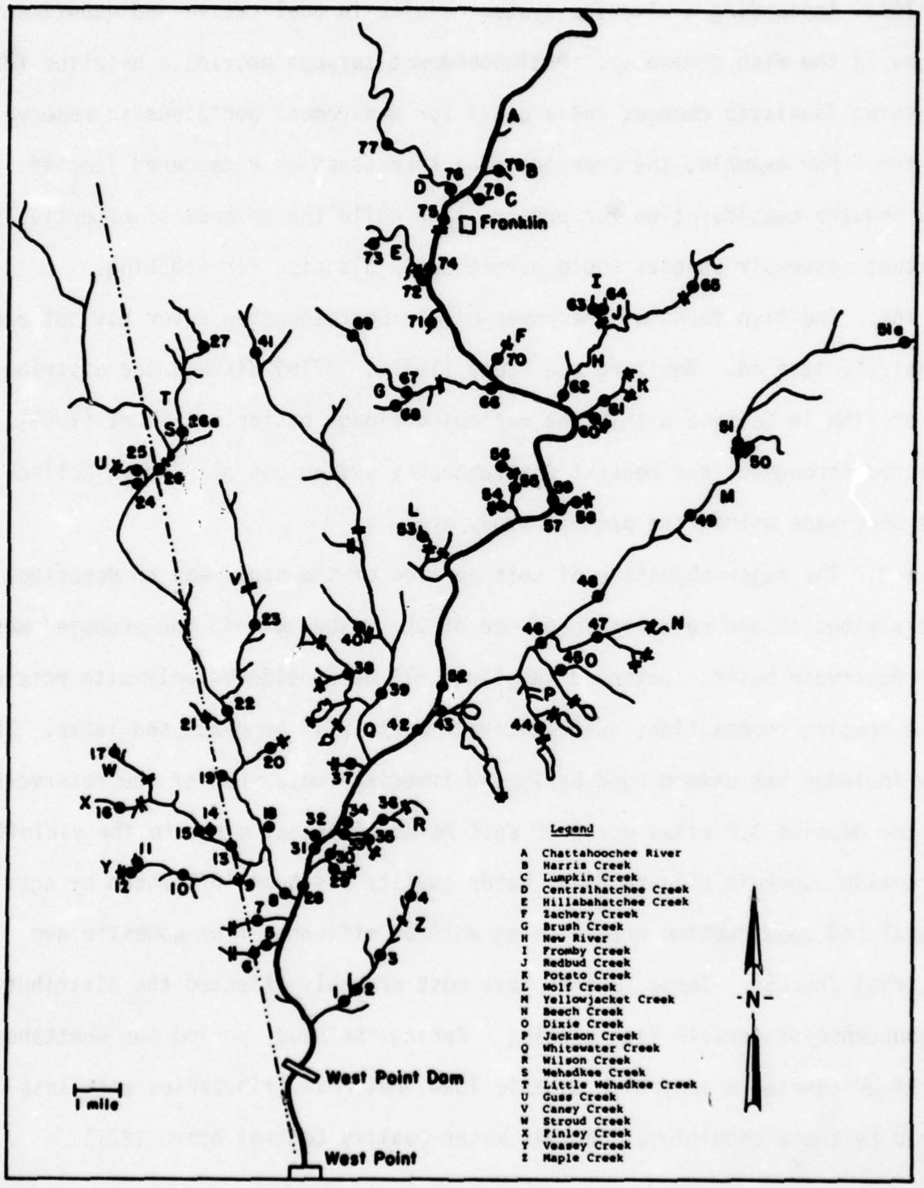

Figure 23. Preimpoundment collection sites in the West Point Reservoir area. Double parallel lines designate the upper reaches of the reservoir at summer pool on the various tributaries.

166. The analysis is based on 96 personal collections at 79 locations (Figure 23) made from January 1972 to May 1974 and seven collections made in 1967 (Gilbert 1969) which add two locations. Nearly all sites were stream samples including beaver ponds; very few watershed ponds were sampled. An annotated species list with common names following Bailey (1970) and collection site information are included in Shelton and Davies (1977).

167. Collecting methods included seining (12- by 4-foot, 3/16-inch bar mesh) electrofishing (boat-mounted, 110-volt A.C. generator through a variable-voltage pulsator which converted to D.C. and matched the output to the water conductivity), and rotenone. Rotenone samples were taken at 8 locations by blocking a 300- to 600-foot section of stream with nets of 3/16-inch mesh, applying the toxicant upstream at 2 ppm, and detoxifying with 4 ppm of potassium permanganate.

168. Field collections were preserved in 10% formalin and returned to the laboratory for identification. Some of the larger specimens were not preserved but were identified in the field. All other specimens are deposited in the Auburn University Department of Fisheries Ichthyological collection.

169. The preimpoundment survey of West Point Reservoir revealed the presence of 53 species representing 14 families of which 15 species were cyprinids, 12 were centrarchids, 7 were catastomids, and 6 were ictalurids. Three Apalachicola drainage endemic species were collected within the study area; range extensions were recorded for 6 species, and recent introductions were taken that had not been previously reported in this segment of the drainage.

170. The endemic species are not considered endangered or threatened in the study area. These species may respond differently to the inundation of

former habitats. *Notropis callitaenia* was collected at 9 locations, all of which were in or directly associated with the main river. This species will probably disappear from the reservoir basin following impoundment due to habitat alteration and increased predation. One of the endemic species in the drainage, an undescribed castamoid, *Moxostoma* sp. cf. *poecilurum*, was collected at 10 sites which were not localized; this species will possibly persist in the reservoir if spawning habitat is available. *Micropterus* sp. cf. *coosae* was collected at only 4 locations, 3 of which were in the Chattahoochee River. This species has persisted in Bartlett's Ferry Reservoir and will probably maintain itself in limited numbers in West Point Reservoir.

171. Three introduced species were collected in the study area, two of which had only recently been discovered in the drainage. *Notropis lutrensis* was collected at 8 locations, all of which were in the Chattahoochee River or near the mouth of tributaries to the river. This species has been collected in Halawakee Creek, a tributary to Bartlett's Ferry Reservoir, and apparently has been widely introduced in the upper Chattahoochee as live bait (Personal communication, J. S. Ramsey[1]). *N. lutrensis* was not reported by Dahlberg and Scott (1971 a & b), Gilbert (1969), or Smith-Vanis (1968). Hybrids of *N. lutrensis* and *N. venustus* were found at 8 locations along the main river. *Pimephales promelas* was collected at only one location in the present study. This species was listed as a "bait-bucket" introduction in Georgia but not in the Apalachicola drainage (Dahlberg and Scott 1971a). *Ictalurus melas* has not been reported from the Chattahoochee system (Smith-Vanis 1968), but was collected at two locations in the present study.

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[1] Unit Leader, Alabama Cooperative Fishery Research Unit, Auburn, Alabama.

172. The range of several species was extended northward on the Piedmont by collections from the present study. Lepisosteus osseus was collected at 3 locations, all in the Chattahoochee River or in the mouth of tributaries to the river. Amia calva was collected at 6 locations, 5 of which were in the river or in close proximity. One specimen of Esox niger was collected by R. Gilbert in the vicinity of the present study but higher in the watershed. It is likely that these species will become established in the reservoir. Notropis atrapiculus was collected abundantly in one tributary system and from scattered locations to the northernmost area of study. Labidesthes sicculus was collected at 12 locations throughout the basin. Centrarchus macropterus was collected at only 2 locations and these were stream sites altered by beaver activity.

173. Several species that are in the drainage were conspicuous by their absence from the present survey. It is possible that several of these will appear in the reservoir as the habitat becomes more favorable for their development. Cyprinus carpio, Carassius auratus, and Morone chrysops are in Lake Lanier (Dahlberg and Scott 1971a), but were not collected in the present effort. Goldfish and carp will probably appear in the reservoir, but it is less likely that white bass will become established. Dorosoma petenense is also in Lake Lanier, but was not collected in the early portion of the study. The importance of this species as a forage fish suggested stocking would be desirable. In 1973 and 1974, personnel from Auburn University and Georgia Dept. of Natural Resources stocked a total of 4,000 adults in two ponds which would be inundated when the reservoir filled. Spawning had occurred in one pond by 1973 as young-of-the-year were collected in a rotenone sample of the stream below this area.

174. Several other species have been introduced into the Chattahoochee River (Dahlberg and Scott 1971a), but not collected in the study area. Salmo

gairdneri, Stizostedion vitreum, Stizostedion canadense, and Micropterus dolomieui have been stocked in Lake Lanier or its tailwaters. It is possible but not likely that one or more of these species could appear in West Point Reservoir.

Preimpoundment Standing Stock

175. Estimates of standing stock in weight/area were accomplished by poisoning sections of streams with rotenone. The limits of the rotenone sample areas were defined by block nets. The nets were 90 ft × 8 ft constructed of 3/16-inch delta webbing with large floats and a leadcore line. Additional weights were required and spacing depended on current velocity of the stream. Sash weights were attached as needed along the lead line as the net was positioned. In currents of higher velocities the net was bridled at various positions to reduce tension on the end ties.

176. Volume estimates for toxicant applications were usually made prior to the actual sample time. A 5% rotenone formulation was used throughout the survey. The rotenone was distributed near the upstream block net at the concentration of 2 ppm. It was applied so that the entire area between the block nets would remain toxic for a period of 10 minutes. The amount of rotenone depended on the volume between the nets plus a replacement volume for that period. The latter depended directly on the current velocity of the stream.

177. Little guidance was available on stream sampling with rotenone as most literature deals with stream reclamation (Lennon et al. 1971). The technique that TVA[1] has used for years has been to apply rotenone at 1 ppm to a blocked off stream area without specifying a duration of the toxicant within

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[1] TVA = Tennessee Valley Authority.

the sampled area (Personal communication, B. G. Grinstead[1]). This was also the technique used by Hocutt et al. (1973) although they implied that the sampling period was for 30 minutes. In more recent sampling, Johnson and Pasch (1976) actually applied rotenone for 45 minutes. Thus, the approach for this study was a compromise between these techniques even though neither had been accomplished at the time of this sampling. There has been no critical study to determine whether a 45-minute period is needed or if a 10-minute duration is adequate.

178. The toxicant was distributed by hand sprayers in smaller streams and by a motorized pump in larger ones. Hand sprayers were also used to distribute rotenone along the stream margins. Potassium permanganate at 4 ppm was applied downstream of the lower net to oxidize the toxicant. It was distributed either by hand or placed in small bags tied to a rope across the stream. The rope could be lowered into the water at the appropriate time. More problems developed in relation to permanganate application than any other single item. It oxidized cloth bags rapidly and dissolved too slowly from plastic bags. Probably the best approach would be to dissolve the permanganate in tubs similar to the dilution of the rotenone and apply the solution.

179. Fish were recovered as they appeared during the operation. No second day collections were attempted as the nets were too difficult to maintain in position. It was assumed that most of the fishes would be carried by the current into the lower net. Larger fish were measured in the field; most or all of these were preserved along with all smaller species and individuals for more detailed examination. Additional information on these efforts is included in Shelton (1974); other characteristics are presented in Table 52.

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[1] B. G. Grinstead, Division of Forestry, Fisheries, and Wildlife, Tennessee Valley Authority, Norris, Tennessee.

Table 52

Description of rotenone sites in 1973.

Tributary	Mean width (ft)	Mean depth (ft)	Current (ft/sec)	Flow (ft^3/sec)	Length (ft)	Area (a)
Wilson	22.2	1.6	0.20	9.3	300	0.15
Veasey	60.0	3.5	0.06	12.7	289	0.40
Stroud	59.0	3.2	0.50	77.5	300	0.41
Wehadkee						
-McCosh	52.6	3.4	1.20	214.6	325	0.40
-Mouth	81.0	3.3	1.50	395.2	200	0.37
New River	59.5	3.0	0.61	109.0	325	0.44
Yellowjacket	73.0	3.4	1.90	471.2	[illegible]	0.50
Centralhatchee	57.5	2.6	0.60	89.0	650	0.86
Cattahoochee						
-Initial	63.0	4.8	0.33	98.0	300	0.43
-After water rise	63.0	5-6	1.40	580.0	300	0.43

180. Wilson Creek (Site 33, Figure 23) is a moderately small tributary to the Chattahoochee River and the sample site was located 600 ft from the confluence. The elevation at that point was 580 to 585 ft msl. The bottom of the stream was very uniform with deeper areas limited to undercut banks. The water was moderately clear (28 JTU) with a water temperature of 73-75°F on 28 June 1973.

181. Veasey Creek (Site 12, Figure 23) is a tributary to Stroud Creek and the sample site was 5.6 river miles upstream from the mouth. The elevation of the site was 640 to 645 ft msl, so will be above the proposed lake level. Extensive beaver activity produced an impounding effect on the tributary and affected the surrounding area which was swampy. The water level was very

stable which encouraged marginal vegetation. Turbidity was high (45 JTU) and the water temperature was 75°F on 3 July 1973.

182. Chattahoochee River (Site 59, Figure 23) at a location 4.7 river miles south of New River was chosen as a sample site. The river throughout this region had a high current velocity. The area selected for sampling was on the east side of the northernmost Swanson's Island where the main river flow was on the west side of the island. The current on the east side was 0.33 ft/second compared to 3.1 ft/second in the main channel. The elevation was 610 to 620 ft msl. The turbidity was low (12 to 15 JTU) and the water temperature was 80° to 81°F on 7 September 1973.

183. The river fluctuated abruptly under the influence of precipitation and discharge from Lake Sidney Lanier. Water fluctuations following peak discharges from Lanier were delayed several days at the study site and were not always predictable. Following initial preparation, including positioning the block nets, the water rose abruptly about 1 to 2 ft and both nets were washed out. Periodic visits substantiated the irregular pulses. No further attempt was made at this location.

184. Yellowjacket Creek (Site 43, Figure 23) was a major tributary of the Chattahoochee River. The sample site was located 1100 ft from the mouth at an elevation of 585 to 590 ft msl. At this location the turbidity was 48 JTU and water temperature was 71°F on 31 August 1973.

185. Stroud Creek (Site 13, Figure 23) is a tributary to Wehadkee Creek. The sample site was located 1.1 river miles from the confluence of the two. The elevation of the sample area was 585 to 590 ft msl. The surrounding area was marshy as discussed for Veasey Creek. Turbidity was high (59 JTU) with a water temperature of 75°F on 9 July 1973.

186. Wehadkee Creek (Site 26, Figure 23) at McCosh Mill was one of two sample areas on Wehadkee Creek. The stream was a major tributary to the Chattahoochee River. This sample area was located 11 river miles from the mouth. The stream at this level was 625 to 630 ft above msl, close to the planned operating pool. The stream was turbid (50 JTU) when sampled, although it was usually clearer. The water temperature was 71° to 72°F on 19 July 1973.

187. Wehadkee Creek (Site 8, Figure 23) was also sampled at a site one half mile upstream from the confluence with the Chattahoochee River. The elevation was 575 to 580 ft msl. The study area included one large riffle. The turbidity was low (8.5 JTU) and the water temperature was 75°F on 27 July 1973.

188. New River (Site 65, Figure 23) was a major tributary to the Chattahoochee River. The study area was 6.7 river miles from the mouth. The elevation was 640 to 645 ft msl which was above the proposed reservoir level. Turbidity was low (10 JTU) on 23 August 1973.

189. Centralhatchee Creek (Site 76, Figure 23) was sampled in an area 500 ft from its confluence with the Chattahoochee River. The water was very clear (<5 JTU) and the water temperature was 67° to 71°F on 17 May 1974. The area of this sample was expanded, as previous experience indicated a larger area would be desirable.

190. Standing stocks of fishes obtained from this study indicated variation between tributaries. The estimates, however, were of the same order of magnitude (Table 53) and are typical for standing stocks reported in streams of similar chemical composition (Swingle 1954).

191. The percentage by weight for various species (E value, Swingle 1950) was generally larger (Table 53) than those reported by Swingle (1954).

Table 53

Standing stock and percentage by weight (E) for representative fishes within the West Point basin.

Species	Wilson	Veasey	Stroud	Wehadkee (McCosh)	Wehadkee (Mouth)	New River	Yellow-jacket	Central-hatchee
L. auritus	3.34	8.37	2.03	2.8	0.61	6.41	2.42	14.96
L. macrochirus	5.09	5.09	6.76	4.31	1.65	7.01	6.80	1.48
M. salmoides	1.18	7.4	3.00	13.90	-	5.98	1.52	31.59
M. sp. cf. *poecilurum*	-	-	18.72	-	-	-	-	0.01
M. melanops	-	7.58	2.61	4.48	-	4.17	4.71	14.28
I. punctatus	-	-	-	2.53	10.87	3.81	4.37	12.71
Total weight of above fishes (lb/a)	3.97	8.26	15.80	5.00	2.65	5.61	2.86	66.72
Total weight all species in sample (lb/a)	41.23	29.02	46.24	17.84	31.06	16.53	14.41	87.70

However, the streams sampled by Swingle were equivalent in size to the Chattahoochee River.

192. The Wehadkee Creek sample at the mouth was not considered representative. Observations made during stocking indicated that the area was more similar to Centralhatchee Creek in size of fishes and their abundance. Size of the area sampled with rotenone was too small to be representative of the area.

Postimpoundment Changes in the Fish Population

193. Intensive sampling of the fish population in the Chattahoochee River before and after impoundment of West Point Reservoir was conducted from January 1972 to September 1977 (Davies and Shelton 1976). The relative abundance of most fish species changes as the habitat is altered from river to reservoir (Elrod and Hassler 1971, Fitz 1968, Gasaway 1970, Patriarche and Campbell 1958, Wahlburg and Nelson 1966). Some species disappear immediately and others may spawn successfully the first year, only to disappear later; some species uncommon in the river become abundant in the reservoir. This study documents the species changes in West Point Reservoir during the first two years after impoundment.

194. The study began in the summer of 1975 after the reservoir had reached the normal pool level for the first time. Collections included: (1) 192 nearshore samples, each sample taken during 45 minutes of electrofishing (boat-mounted, 110-volt A.C. generator and a pulsator which provided variable D.C. voltage); (2) 12 samples from coves treated with rotenone (average surface area, 2.0 a) of which two coves were sampled three times each and six others, selected at random, were treated once; (3) 120 shoreline rotenone samples of 0.02 a, each blocked off with a 3/16-in. mesh net 100 ft long and 9 ft deep; (4) 45 overnight sets of experimental gill nets (monofilament nylon, 125 × 6 ft, of five mesh sizes from 1.0 to 3.0 in., bar measure; and (5) 500 samples with a 1/8-in. mesh seine (4 × 12 ft) and 250 samples with a 1/8-in. mesh bag seine (50 × 6 ft).

195. Fifty-three species of fishes were collected in the West Point Reservoir area before impoundment. After impoundment 11 were not collected

again, 5 disappeared during the first year, and 37 were found in the reservoir 2 years after impoundment (Table 54).

196. Six species not reported in the preimpoundment study (Shelton and Davis 1977) have appeared in the reservoir (Table 54). They were probably not collected earlier because they were uncommon in the river and/or their habitat was difficult to sample adequately. Gilbert (1969) described the swamp darter and the dollar sunfish as rare in the middle Chattahoochee River region. Although uncommon, both have been collected in all parts of the reservoir and postimpoundment collections extend their northern range in the river. Walleyes have been stocked in Lake Sidney Lanier and its tailwater, 113 river miles upstream from the headwaters of West Point Reservoir (Dahlberg and Scott 1971b). The single walleye collected in this study can probably be attributed to those stocked fish. White catfish may not have been collected earlier because they were uncommon and it was difficult to sample adequately the deep pools in the river. Goldfish probably originated from ponds inundated by the reservoir or possibly as discarded bait minnows.

197. No carp were collected before impoundment, but they were known to be in the watershed. After impoundment the few present produced a strong 1975 year class. One (2.0 a) cove in the upper reservoir had 216 carp per acre (mostly young-of-the-year) in the summer of 1975. The average number of carp per acre from the coves decreased from 65 in 1975 to 15 in 1977, although the weight per acre was almost the same (Table 55).

198. Before impoundment redfin pickerel were common, but no chain pickerel were collected (Shelton and Davies 1977); however, one chain pickerel was collected by Gilbert (1969). The two species of pickerel spawned during the first year of impoundment. In the Yellowjacket Creek cove in 1975 there were 27

Table 54

Fishes collected in West Point Reservoir area, January 1972-May 1977.

Both Before and Two Years After Impoundment	
Longnose gar	Lepisosteus osseus
Bowfin	Amia calva
Gizzard shad	Dorosoma cepedianum
Threadfin shad	D. petenense
Chain pickerel	Esox niger
Undescribed chub	Hybopsis sp. cf. H. winchelli
Golden shiner	Notemigonus crysoleucas
Blacktip shiner	Notropis atrapiculus
Bluestripe shiner	N. callitaenia
Longnose shiner	N. longirostris
Red shiner	N. lutrensis
Weed shiner	N. texanus
Blacktail shiner	N. venustus
Quillback	Carpiodes cyprinus
Creek chubsucker	Erimyzon oblongus
Spotted sucker	Minytrema melanops
Greater jumprock	Moxostoma lachneri
Undescribed sucker	M. sp. cf. M. poecilurum
Snail bullhead	Ictalurus brunneus
Black bullhead	I. melas
Yellow bullhead	I. natalis
Brown bullhead	I. nebulosus
Channel catfish	I. punctatus

Table 54 (continued)

Mosquitofish	Gambusia affinis
Brook silverside	Labidesthes sicculus
Flier	Centrarchus macropterus
Redbreast sunfish	Lepomis auritus
Green sunfish	L. cyanellus
Warmouth	L. gulosus
Bluegill	L. macrochirus
Redear sunfish	L. microlophus
Spotted bass	Microterus punctulatus
Largemouth bass	M. salmoides
Undescribed bass	M. sp. cf. M. coosae
Black crappie	Pomoxis nigromaculatus
Yellow perch	Perca flavescens
Before Impoundment Only	
Bluehead chub	Nocomis leptocephalus
Highscale shiner	Notropis hypsilepis
Bandfin shiner	N. zonistius
Fathead minnow	Pimephales promelas
Creek chub	Semotilus atromaculatus
Lake chubsucker	Erimyzon succetta
Alabama hogsucker	Hypentelium etowanum
Speckled madtom	Noturus Leptacanthus
Southern studfish	Fundulus stellifer
Redeye bass	Micropterus coosae
Banded sculpin	Cottus carolinae

Table 54 (continued)

Before and After Impoundment but Disappearing	
After One Year	
Southern brook lamprey	*Ichthyomyzon gagei*
Redfin pickerel	*Esox americanus*
Stoneroller	*Campostoma anomalum*
Silverjaw minnow	*Ericymba buccata*
Blackbanded darter	*Percina nigrofasciata*
After Impoundment Only	
Goldfish	*Carassius auratus*
Carp	*Cyprinus carpio*
White catfish	*Ictalurus catus*
Dollar sunfish	*Lepomis marginatus*
Swamp darter	*Etheostoma fusiforme*
Walleye	*Stizostedion vitreum*

Table 55

Estimated average number and weight of fishes per acre in coves of West Point Reservoir based on rotenone samples taken in 1975-77.

	1975				1976				1977			
Species	No./a	(s.d.)	lb/a	(s.d.)	No./a	(s.d.)	lb/a	(s.d.)	No./a	(s.d.)	lb/a	(s.d.)
Gizzard shad	3,016	3,519	91.6	99.3	3,375	4,986	199.5	319.0	23,758	39,515	709.9	1,169.5
Black crappie	1,642	1,182	40.8	33.7	133	166	6.8	9.3	194	125	11.0	14.1
Golden shiner	693	686	13.2	17.4	14	4	0.6	0.1	10	6	0.4	0.4
Largemouth bass	621	188	30.4	12.1	79	29	14.0	13.6	54	43	7.5	1.8
Bluegill	543	717	25.2	27.4	1,227	332	20.8	12.9	8,818	2,024	42.3	15.0
Brown bullhead	516	221	26.8	5.4	135	98	18.1	19.0	27	36	4.4	5.5
Threadfin shad	406	628	7.6	15.1	1,229	392	8.9	10.2	775	1,078	10.8	12.9
Green sunfish	274	171	12.2	12.1	224	96	4.1	2.1	183	40	4.1	2.1
Warmouth	133	84	4.3	3.9	92	125	2.9	4.3	27	47	0.4	0.4
Flier	127	130	2.1	3.0	61	105	3.4	7.1	*	--	**	--
Redfin pickerel	101	128	4.4	5.5	0	--	0	--	0	--	0	--
Carp	65	101	22.8	34.2	8	9	12.5	15.9	15	21	22.5	28.9
Bowfin	47	24	22.0	16.6	7	1	4.1	3.0	*	--	2.0	--
Redear sunfish	40	71	1.5	2.1	49	83	2.1	3.8	21	21	1.3	1.4
Spotted sunfish	38	44	2.4	3.8	17	25	1.1	1.2	3	3	**	--

Table 55 (continued)

Species	1975				1976				1977			
	No./a	(s.d.)	lb/a	(s.d.)	No./a	(s.d.)	lb/a	(s.d.)	No./a	(s.d.)	lb/a	(s.d.)
Creek chubsucker	33	15	4.3	2.2	9	5	4.0	3.5	2	1	1.2	0.8
Yellow perch	23	25	0.9	1.0	4	4	0.4	0.1	53	61	0.4	0.2
Redbreast sunfish	19	21	2.3	3.4	129	102	3.5	0.6	274	143	7.8	4.6
Yellow bullhead	13	5	1.4	0.5	12	12	0.7	0.9	1	1	**	--
Spotted bass	12	23	1.2	3.1	5	11	**	--	2	4	0.2	0.2
Channel catfish	9	18	7.7	17.7	9	17	3.7	8.3	9	10.4	3.1	3.3
Chain pickerel	8	13	1.2	2.8	1	2	0.4	1.0	0	--	0	--
Black bullhead	8	7	0.4	0.2	0	--	0	--	0	--	0	--
Quillback	4	8	11.4	28.7	0	--	0	--	0	--	0	--
Spotted sucker	4	8	10.2	25.6	*	--	0.7	1.9	*	--	0.5	--
Others***	13	--	0.1	--	51	--	0.1	--	42	--	1.7	--
Total	8,409		348.6		6,874		312.7		34,269		831.4	

*less than 1.
**less than 0.1.
***southern brook lamprey, longnose gar, stoneroller, red shiner, weed shiner, undescribed chub, greater jumprock, undescribed sucker, snail bullhead, mosquitofish, brook silverside, dollar sunfish, swamp darter, blackbanded darter.

chain pickerel and 292 redfin pickerel per acre. An average of 101 redfin pickerel per acre were collected in 1975 from four cove samples. In 1976 and 1977 no redfin pickerel were found in rotenone samples. The disappearance of redfin pickerel in electrofishing samples is shown in Figure 24. The chain pickerel prefers larger bodies of water than the redfin pickerel and usually replaces it in reservoirs (Crossman 1966).

199. Four species of fish found during the first full year of impoundment have not been collected since: southern brook lamprey, stoneroller, silverjaw minnow, and blackbanded darter. These fishes would be expected to be in streams flowing into the reservoir and not altered by inundation.

200. Eleven species were collected before impoundment but not after impoundment (Table 54). Most were fishes usually found in streams with moderate current. It is probable that these species still occur in streams flowing into the reservoir.

201. Thirty-seven species were collected both before impoundment and through 2 years after impoundment (Table 54). Gizzard shad had become the most important species, both in number and weight by 1975 (Table 55). By 1977 there was an estimated average of 23,759 gizzard shad per acre in coves (709.9 lb/a). Threadfin shad were increasing in number and the extreme winter of 1976-1977 did not eliminate the population, even though large numbers of dead were observed in February 1977.

202. The important game fishes in the reservoir were largemouth bass, bluegill, black crappie, and channel catfish. Largemouth bass produced a large year class in 1975 with upper and lower limits of 401 and 840 bass and 19.5 to 38.8 lb/a. The 1976 and 1977 year classes of largemouth bass were relatively weak. The estimated average number of largemouth bass per acre in coves

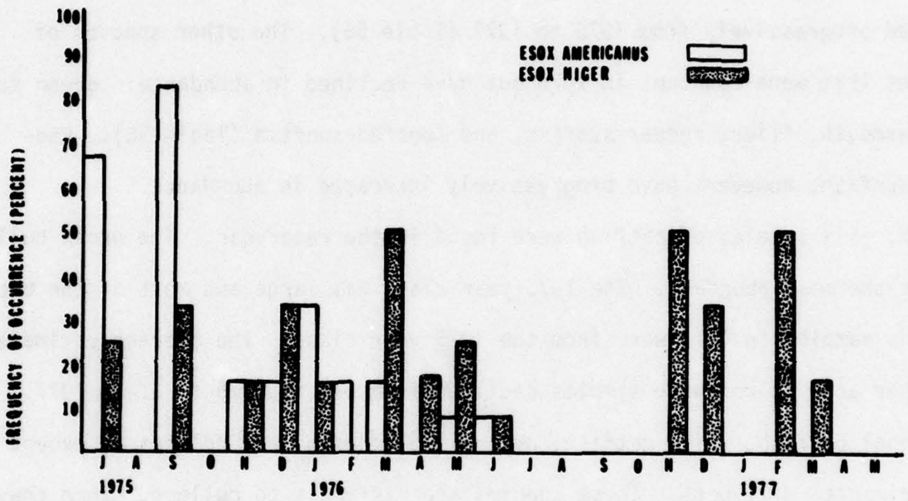

Figure 24. Frequency of occurrence of pickerel in monthly electrofishing samples from July 1975 to May 1976 (192 samples--45 minutes of electrofishing/sample) in West Point Reservoir. Usually 6 samples/month from Sept. through March and 12 samples/month from April through Aug.

declined from 621 in 1975 to 79 in 1976 and to 54 in 1977. No redeye bass and only two of the undescribed "shoal bass" were collected in the reservoir. Occasional spotted bass were taken.

203. The black crappie was the second most abundant species numerically and by weight in 1975 (Table 55). It declined after 1975 but was still common in the 1977 samples.

204. The bluegill was abundant in 1975 and the average number and weight increased progressively from 1975 to 1977 (Table 55). The other species of sunfishes that were abundant in 1975 but have declined in abundance: green sunfish, warmouth, flier, redear sunfish, and spotted sunfish (Table 55). Redbreast sunfish, however, have progressively increased in abundance.

205. Six species of catfish were found in the reservoir. The brown bullhead was the most abundant. The 1975 year class was large and most of the brown bullheads sampled in 1977 were from the 1975 year class. The average estimated number per acre in rotenone samples declined from 516 in 1975 to 27 in 1977. Few channel catfish, white catfish, or snail bullheads were collected, except in experimental gill nets. These species are difficult to collect, since they apparently prefer deep holes in channels (McLane 1955).

206. The golden shiner was the third-most-abundant species in 1975, when there were 693 (13.2 lb) per acre. Samples in 1976 and 1977 suggested a marked decline in abundance (Table 55). Other cyprinids, except carp, were uncommon. In 1977 the golden shiner, weed shiner, blacktail shiner, and red shiner were occasionally taken from samples near shore.

207. Five species endemic to the Apalachicola River drainage were collected in the study area before impoundment. The highscale shiner was not collected after impoundment. The undescribed "grayfin redhorse" and the

greater jumprock were uncommon in the reservoir. The bluestripe shiner and the undescribed "shoal bass" were uncommon in the reservoir; both have been listed as species of special concern by Ramsey (1976). Only juveniles of the shoal bass have been collected in the study area since impoundment.

Species Biology and Dynamics

Largemouth Bass

208. Variation in the growth of largemouth bass between years has been well documented in age and growth studies, but variation within a single year class has been discussed less frequently. Rates of growth of young-of-the-year largemouth bass are reported by Viosca (1952), Lambou (1959), Kramer and Smith (1960), and Chew (1974).

209. Growth is influenced by year-class strength for which causative factors have been discussed by Patriarche and Campbell (1958), Jackson (1959), Kramer and Smith (1962), Bross (1968), Rainwater and Houser (1975), Romero and Allen (1975), and Eipper (1975). Physical factors such as water level fluctuation, temperature changes, and wave action have been implicated as affecting the potential reproductive success within a year, but the availability of suitable prey is necessary for the continued growth and development of the year class.

210. Growth variation within a single year class can be influenced by these same factors, but few workers have addressed this phenomenon. Climatological factors have been correlated with size disparity of a year class of largemouth bass (Summerfelt 1975).

211. Rapidly falling temperatures can disrupt spawning or mating activities and if the unsuitable conditions persist, may delay the resumption of spawning. The resulting disparity in age of the offspring may affect the relative growth of the groups. The production of prey can be differentially affected by the same conditions depending on species spawning time. For example, if spawning of the prey species were complete prior to the disruptive conditions, then subsequently spawned bass might be too small to utilize the prey.

212. Food availability has been suggested as a factor that differentially

affects growth and reinforces age-caused size differences (Applegate et al. 1967, Rainwater and Houser 1975, Aggus and Elliott 1975). Limitations might be actual shortage of prey (Rainwater and Houser 1975) or relative to the size availability (Kimsey 1958, Jenkins and Morais in press).

213. Largemouth bass feed on fish increasingly at sizes above 2 inches TL, becoming principally piscivorous larger than 3 to 4 inches TL[1] (McCammon et al. 1964, Applegate et al. 1967, Chew 1974). Availability of food items affects this transition to a certain extent (Applegate and Mullan 1967). The size of prey that can be eaten by bass was discussed by Lawrence (1959) and further investigated by Tarrant (1960), Snow (1971), and Jenkins and Morais (in press). In general, a largemouth bass can eat prey 30 to 50% its own total length. There are, however, indications that fish predators take progressively smaller prey than they are capable of swallowing as they grow (Popova 1967); the availability of prey throughout the size range is of major concern and has been well discussed (Jenkins and Morais in press). Aggus and Elliott (1975) report that within a largemouth bass population some individuals begin to feed on fishes earlier than others. This tendency is not initially size related, but the piscivorous habit results in a growth advantage.

214. The intrayear growth difference may be manifested as multimodal length frequencies (Summerfelt 1975). Intrayear growth variation is an important consideration for several reasons. Age and growth studies use length-frequency distribution to validate back-calculated lengths. An observed bimodal distribution of a single year class might explain a discrepancy between fish of two modal lengths but with a single annulus. Also, population models assume growth rates within a year class to be fairly equivalent or at least not widely

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[1] TL = total length.

distributed. Greatly differing growth rates of a year class could compromise the validity of basic assumptions.

215. The present discussion reports growth variation within the first year class (1975) of largemouth bass from West Point Reservoir and throughout its near demise in 1977. The two intervening year classes, 1976 and 1977, are described and the interrelationships are included.

216. The filling of a new reservoir presents a vast area for fish population expansion and the initial year class of largemouth bass in West Point Reservoir was no exception. No bass were stocked, all reproduction was from the previous river population and from bass in watershed ponds that were inundated. The high production of the young-of-the-year bass is illustrated by the 1975 series of cove rotenone samples. The average observed standing stock for largemouth bass in July-August 1975 was 31.1 lb/a of which 24.4 lb/a was smaller than 10 inches TL. Six hundred and nineteen per acre of these bass were young-of-the-year (Table 56). The high standing stock is in the range (20 to 30 lb/a) described by Jenkins (1975) as being characteristic of new, reclaimed, or drained and refilled reservoirs. This high production developed into a shortage of prey that will be discussed in detail later as will data (Table 56) for the 1976 and 1977 year classes of largemouth bass.

217. Length-frequency analyses throughout the initial year of impoundment illustrate the growth of two groups of bass from the 1975 year class (Figure 25). The July-August 1975 period was dominated by what appeared to be a single mode of young-of-the-year largemouth bass at the modal length of 3 to 4 inches. Although a distinct bimodal distribution was not evident from the frequency diagram, a growth difference was obvious in the appearance of various sizes. Smaller individuals in the year class were in generally poor condition, while the larger members were robust and in good condition.

Table 56

Standing stock of largemouth bass (lb/a) in West Point Reservoir and young-of-the-year recruited (nos./a) from the late summer rotenone samples.

	COVES	I_C*	II	III	IV_C*	Mean
1975	NOS. YOY/A	689	840	551	392	619
	< 10"	26.75	41.25	16.83	12.88	24.4
	> 10"	12.15	1.5	8.64	4.64	6.7
						31.1
1976	NOS. YOY/A	78	68	110	57	78**
	< 10"	3.39	1.95	4.56	3.54	3.4
	> 10"	6.99	1.42	23.57	17.51	12.4
						15.8
1977	NOS. YOY/A	117	104	138	39	100
	< 10"	3.59	3.59	2.51	2.73	3.1
	> 10"	3.42	6.59	3.92	3.64	4.4
						7.5

Note: YOY/A = young-of-the-year per acre.
* = Control Coves, sampled each year, others were sampled only once.
** Includes residual 1975 bass that had grown little.

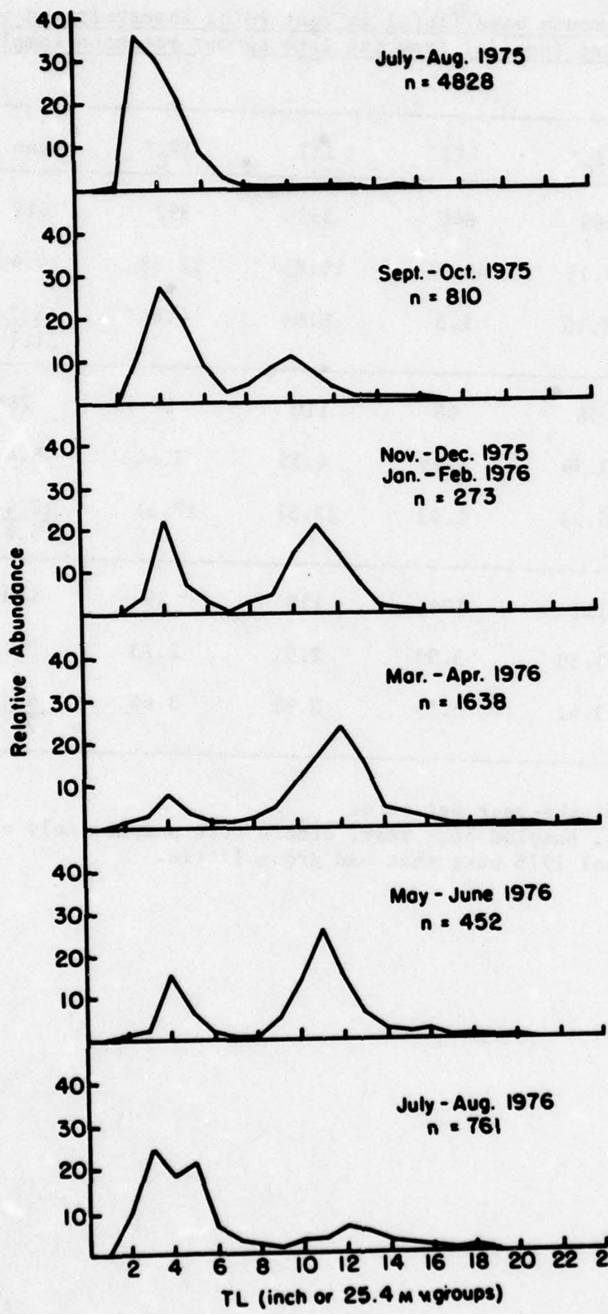

Figure 25. Length frequency of largemouth bass from West Point Reservoir during the first full year of impoundment.

218. Individuals in the 4- to 6-inch groups were thin and emaciated while those larger than 7 inches were robust and deep bodied; fish in the 2- to 3-inch groups were also in good condition although not as plump. A series of typical individuals was selected to illustrate this situation (Figure 26).

219. The relative condition (Kn) of the bass (LeCren 1951) demonstrates the sensitivity of the measure to the general well being of a group of a fish. The basis for comparison using LeCren's Kn was the series of Alabama State averages compiled by Swingle (1972). The Kn value for the 4- to 6-inch groups of bass was less than one while the Kn values for those in the 7-inch group and larger and 2- and 3-inch groups were greater than one (Table 57). Therefore, a very high number (n) of the bass in the population were in relatively poor condition.

Table 57

Relative condition (Kn) values for 1975 year class largemouth bass from West Point Reservoir during July-August 1975

inch-group	n	Kn
2	40	3.21
3	1631	1.14
4	1296	0.81
5	893	0.85
6	368	0.92
7	109	1.04
8	61	1.22
9	16	1.19
10	13	1.21
11	9	1.32
12	4	1.09

220. Later in the year (September-October) the condition disparity was manifested as an obvious growth difference (Figure 25). The smaller size group

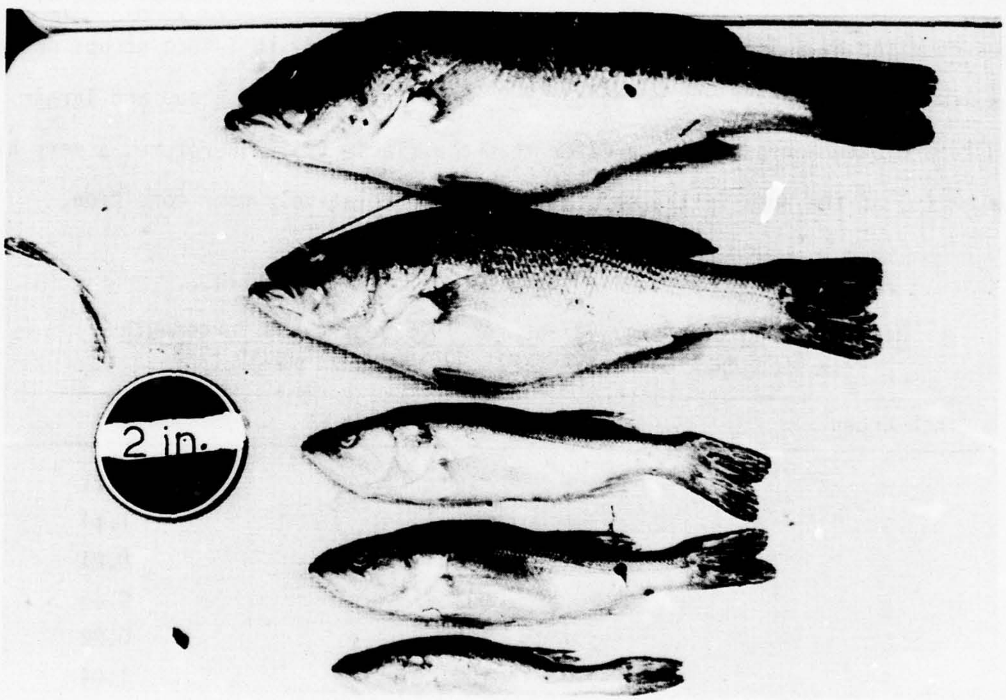

Figure 26. Largemouth bass from 1975 year class in August of 1975.

of bass had grown little while the larger members of the year class were increasing rapidly in size. During the September-October period, many were larger than 10 inches. The condition difference was still very obvious.

221. In the winter period (November, December, January, and February), the disparity between the two size groups of bass had increased further. The more abundant and smaller sized group remained small with the mode still at about 4 inches, while the faster growing group had attained a modal length of 10 to 12 inches.

222. In the March-April collections, size distribution had changed little from the previous months; the modal length of the larger group had increased somewhat but the relative abundance appeared to have been altered considerably (Figure 26). The smaller sized fish were much less abundant than the larger, faster growing members of the year class, probably having suffered a relatively higher mortality during the harsh winter months.

223. The size disparity illustrated in Figure 26 for the March-April period is more graphically illustrated by fish from the extremes of the 1975 year class (Figure 27). The larger fish was 15.5 inches TL and weighed 3.5 pounds while the smaller fish was about 3.5 inches. These fish were the most rapidly growing and slowest growing members of the 1975 year class while the center fish was in the lower range of the second modal group at a total length of about 9 to 10 inches (Figure 25). None of these fish had formed an annulus at the time of the collection in March.

224. Spawning occurred in 1976 during April and May, but few young-of-the-year were collected until July and the mode was not apparent until the July-August period. The length frequency in May-June for the 1975 year class was similar to the March-April period; the mode of the slower growing group was

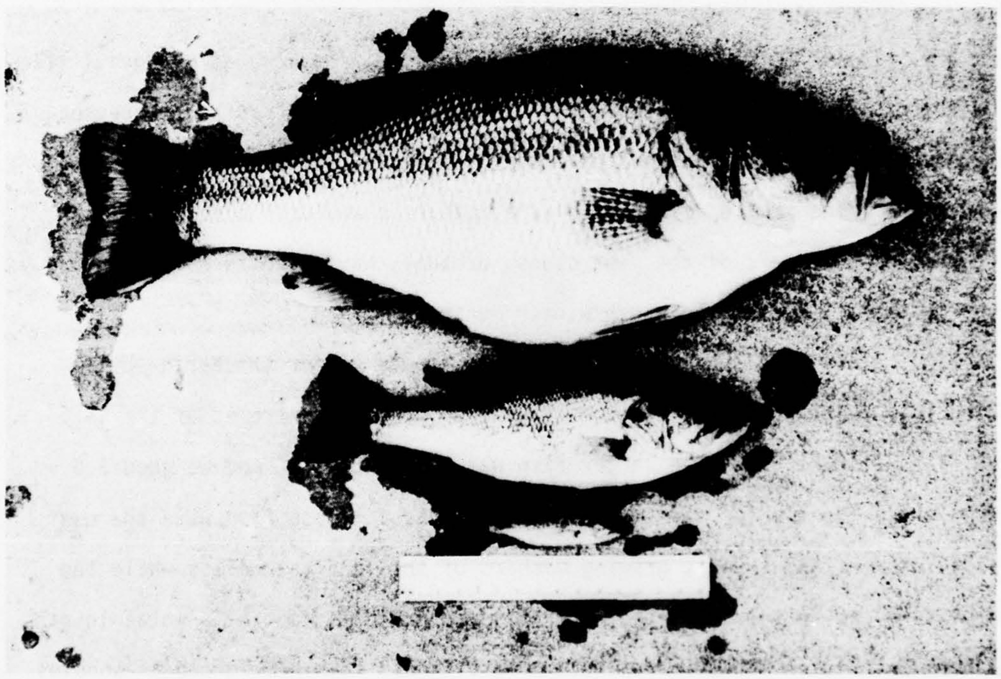

Figure 27. In early 1976, these largemouth bass of the 1975 year class ranged in size from about 4 to 15 inches in length; the largest weighed about 3.50 pounds (Rule is 6" in length).

still at about 4 inches (Figure 25). The upper mode seems to have decreased slightly; however, this may have been a result of increased harvest in this size range (i.e. greater than 12 inches), which was the minimum legal size for Georgia. Creeled bass during this period were predominantly from the 1975 year class and averaged about 1 pound. The effects of harvest on this year class are discussed in the section entitled "Estimated rate of exploitation for the 1975 year class of largemouth bass."

225. In July-August, fish from the 1976 year class were collected in sufficient numbers to be represented as a new mode (Figure 25). This, however, partially merged with the slow growing group of the 1975 year class. The two groups were identifiable by scale examination, as an annulus had formed in the 1975 year class.

226. The slower growing group of the 1975 year class had grown little, if at all, in one complete year. The modal length in July-August 1975 was at about 4 inches and could still be identified in July-August in 1976 at about 5 inches. The stunted portion of 1975 year class apparently did not efficiently utilize prey produced in 1976 and eventually disappeared from the population.

227. While some of the bass in the more rapidly growing group had entered the harvest as early as the fall of 1975, by the spring and summer of 1976 they dominated the catch, averaging about 1 pound. The Georgia minimum length limit for bass was 12 inches and the effect of fishing was not a factor in reducing the number of bass until they grew beyond this minimum harvestable size. By late summer the average harvested bass weighed 1.5 pounds and was about 15 inches in total length.

228. Explanation for growth disparity within this year class of largemouth bass may include variation in spawning times, time of change over to

piscivorous habits by the small bass, or prey availability. All possible causes, to a certain extent, involve food utilization as a factor that would perpetuate and accentuate any size disparity.

229. In the spring of 1975, for example, temperatures were probably high enough for a spawn to have occurred in the latter part of April. The water level was still low as the tree topping operation was being completed. It is likely that survival from subsequent spawns would have been more successful as the temperature was more stable and the water level was constantly rising. The inundation of the second growth vegetation that developed after contour clearing between 600 and 635 ft msl would have provided optimal cover conditions.

230. While the time of spawning may have established an age/size difference, the phenomenon described for the 1975 year class of largemouth bass in West Point Reservoir can be more directly correlated with prey availability. A difference in size may have had its origin in factors affecting spawning time and success during initial filling, but no strong bimodality was apparent in July-August and the subsequent availability of food was probably a more important controlling factor in the development of the growth difference.

231. The availability of prey is a function of the size and body conformity of the prey in relation to the size and mouth dimensions of the predator. A general rule, that bass can swallow shad one half their total length or the deeper bodied sunfishes one third their length, was in general agreement with the food habit observations in the present study (Figure 28). Fishes were the main food item in bass larger than 6 inches. The 30% generalization for sunfishes was about the mean observed from the stomachs examined while the 50% estimate for shad and other comparable shallow-bodied fishes was perhaps a little higher than the mean lengths from the data as most shad that were eaten

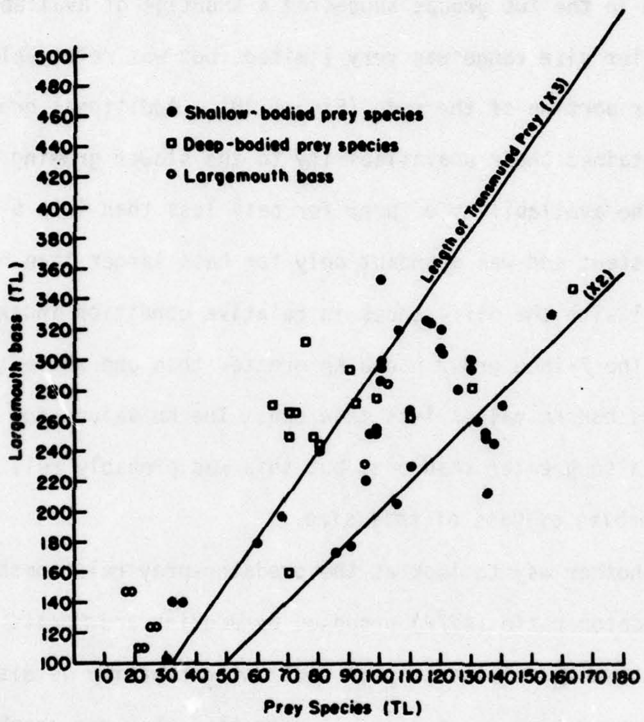

Figure 28. Total length of largemouth bass and prey from stomach examination. The lower line represents one half the bass total length and the upper line is one third the total length.

were generally shorter than one half the total length of the bass. But, as generalizations, the estimates appear to be conservative and if prey are not available in the size range or slightly smaller, there will be a shortage.

232. Size distribution of prey species at the time a condition difference was detected in the two groups suggested a shortage of available prey. Prey for the smaller size range was very limited, but was relatively abundant for the upper portion of the mode (Figure 29). Additional growth of the prey species maintained their unavailability to the slower growing bass.

233. The availability of prey for bass less than 4 to 5 inches was practically nonexistent and was abundant only for bass larger than 6 to 7 inches. This conforms well with the differences in relative condition indexes previously discussed. The 7-inch group had a Kn greater than one while the 4-, 5-, and 6-inch groups had Kn values less than one. The Kn values for the 1- and 2-inch groups were also greater than one, but this was probably related to the insectivorous food habits of bass of this size.

234. Another way to look at the predator-prey relationship is the Available Prey/Predator ratio (AP/P) proposed by Jenkins and Morais (in press). This ratio uses the same relationship in swallowing capacity as discussed above, but assumes that predators do utilize all prey that they are capable of swallowing. The predator category includes "bass-equivalents" so may present a slightly different predator/prey relationship than when only bass are considered. The ratios are graphically presented to illustrate the food conditions for predators. An AP/P plot for the West Point Reservoir population in 1975 is presented in Figure 30. The points below the 45° line suggest a paucity of available prey. Inadequate prey is indicated for predators (bass-equivalents) smaller than the 10-inch group. The discrepancy may be explained in that there was

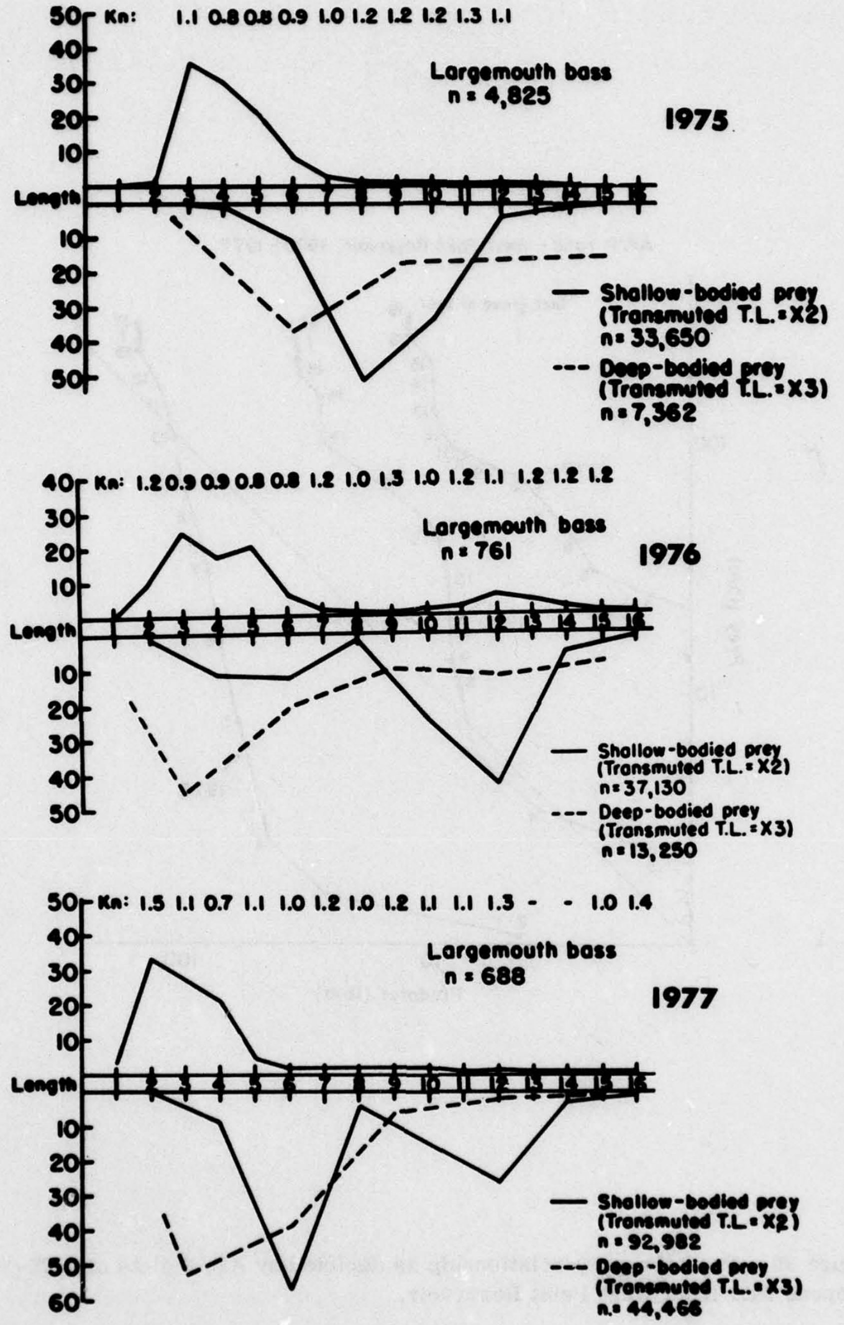

Figure 29. Largemouth bass length frequency and transmuted total lengths of selected prey species (x2 for shallow-bodied prey; x3 for deep-bodied prey) to represent their availability in July-August 1975-1977 in West Point Reservoir.

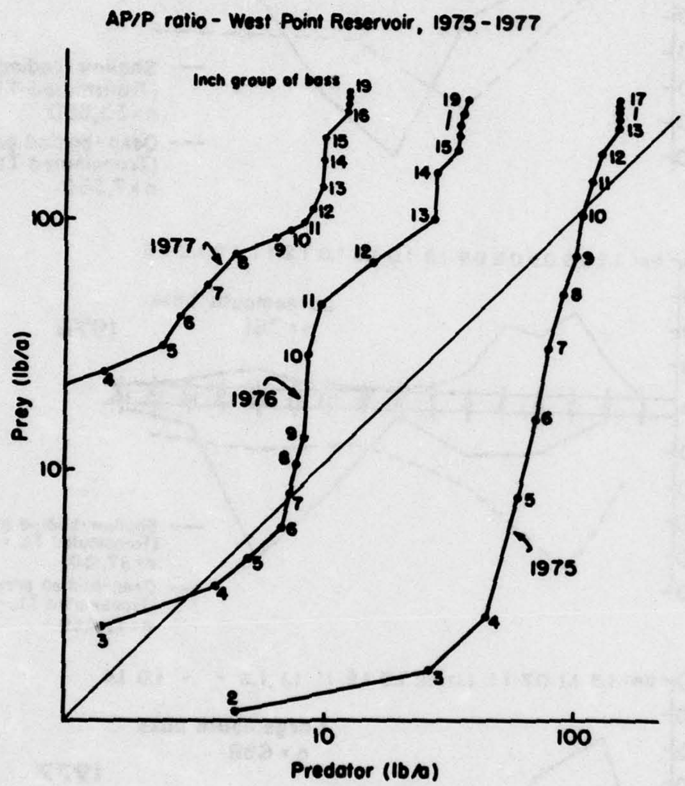

Figure 30. Predator-prey relationship as depicted by AP/P plots of 1975-1977 rotenone data from West Point Reservoir.

also present a very high standing stock of bowfin, also largely the 1975 year class. The average standing stock of bowfin was 22 lb/a and was included in the predator category.

235. Minnows that might have supplied food for the bass in this size range were uncommon. The golden shiner was the only small cyprinid of 12 other species that were present prior to impoundment (Shelton and Davies 1977). The habitat changes following impoundment may have reduced their abundance, but the increased predatory pressure also must have been a factor.

236. The temperature and water level pattern for the spring of 1976 presented no adverse conditions that would suggest a poor year class (Appendix Table 1). However, few young-of-the-year bass were collected throughout the postspawning period.

237. Gonadal data suggest that spawning occurred in the April to May period (Figure 31). Judging from the low GSI,[1] females less than 300 mm total length contributed little to the spawning, while those greater than 300 mm TL showed a marked increase and then a decline in the gonadal weight corresponding to the spawning period. The data suggest that the larger females spawned earlier in the season.

238. The 1976 year class was first evident in the length-frequency data in the late summer rotenone samples (Figure 25). The modal length was about 2 to 3 inches, merging in part with the slow growing group of the 1975 year class. This group had grown less than one inch in a year and appeared to have diminished in abundance especially during the winter months of 1975-1976.

239. The overlap in length of the two year classes made the estimate of young-of-the-year recruitment less accurate than usual. However, even with the contamination from the 1975 year class, the combined total was less than 78 young-of-the-year/acre in the late summer (Table 56).

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[1] GSI = Gonadal-Somatic Index.

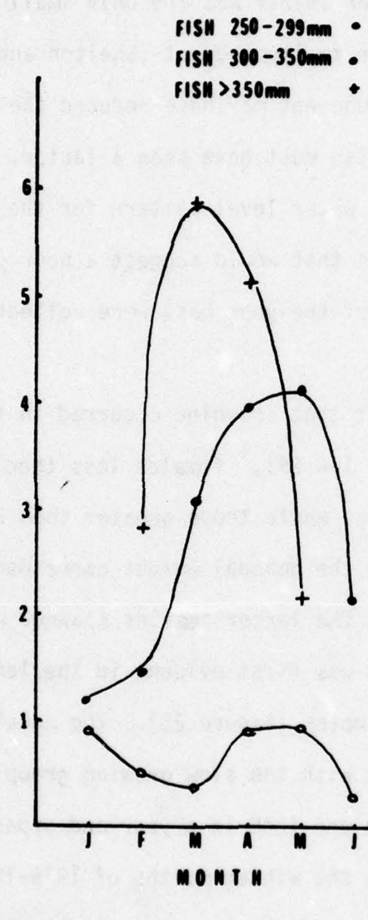

Figure 31. Gonadal-Somatic indexes of female largemouth bass in 1976 from West Point Reservoir.

240. The standing stock of largemouth bass (Table 56) was quite different from the 1975 samples. The total average standing stock in 1976 was 15.8 lb/a of which 12.4 lb/a was bass larger than 10 inches predominantly the 1975 year class. The size distribution presented in Figure 25 suggests that even though the weight is greatest in fish larger than 10 inches, there has been a reduction in relative abundance when compared to the distribution earlier in the summer. As mentioned earlier, bass larger than 12 inches were being harvested.

241. Prey conditions in 1976 were somewhat better than in 1975. Stronger year classes of various prey species resulted in an improved availability, particularly to the smaller bass (Figure 29). It is of interest to note that the relative condition (Kn) of certain sizes of bass was low as noted in 1975. Bass in 3-, 4-, 5- and 6-inch groups had a Kn less than one. There appeared to be an ample supply of various centrarchids (deep-bodied prey) of available sizes, but the abundance of shad for this size range of bass was relatively lower. The AP/P plot for 1976 suggested a shortage of prey for "bass-equivalents" between 4 and 7 inches (Figure 30). Food habits in 1975-76 consisted mainly of fish (Figure 32). Shad were the dominant fish food organism for fish greater than 6 inches. During the winter months, the 1976 year class appeared to surpass the retarded 1975 group, and by March-April of 1977 the mode had moved to about 10 inches in total length (Figure 33). The faster growing group of the 1975 year class had a modal length of about 14 inches during this period. The relative abundance was apparently reduced from the previous year. This size group had originally entered the fishery on a small scale in the fall of 1975 and dominated the catch during 1976; thus, in 1977, it was entering the second year of exploitation.

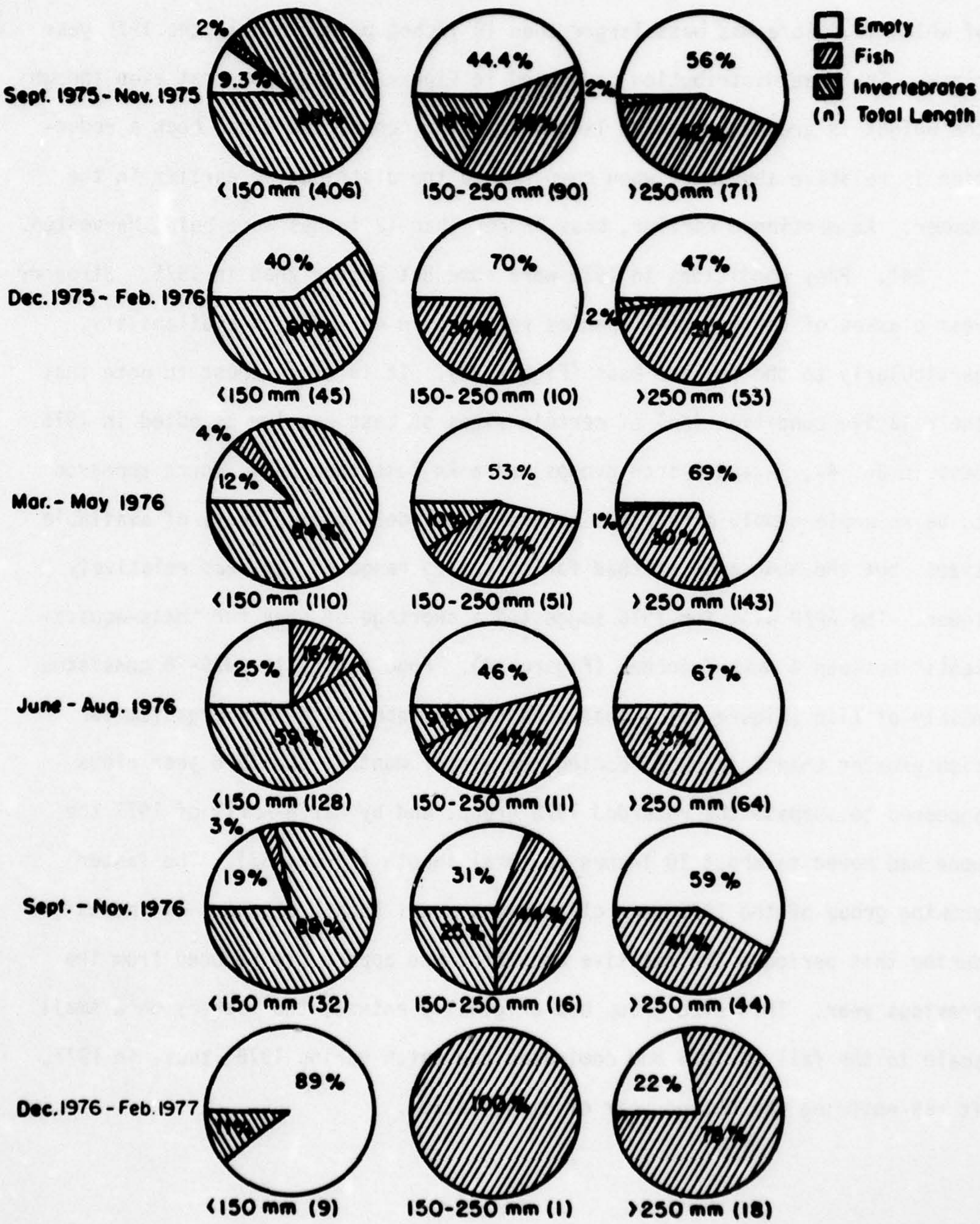

Figure 32. Frequency of occurrence of food items in largemouth bass from West Point Reservoir in 1975-1976.

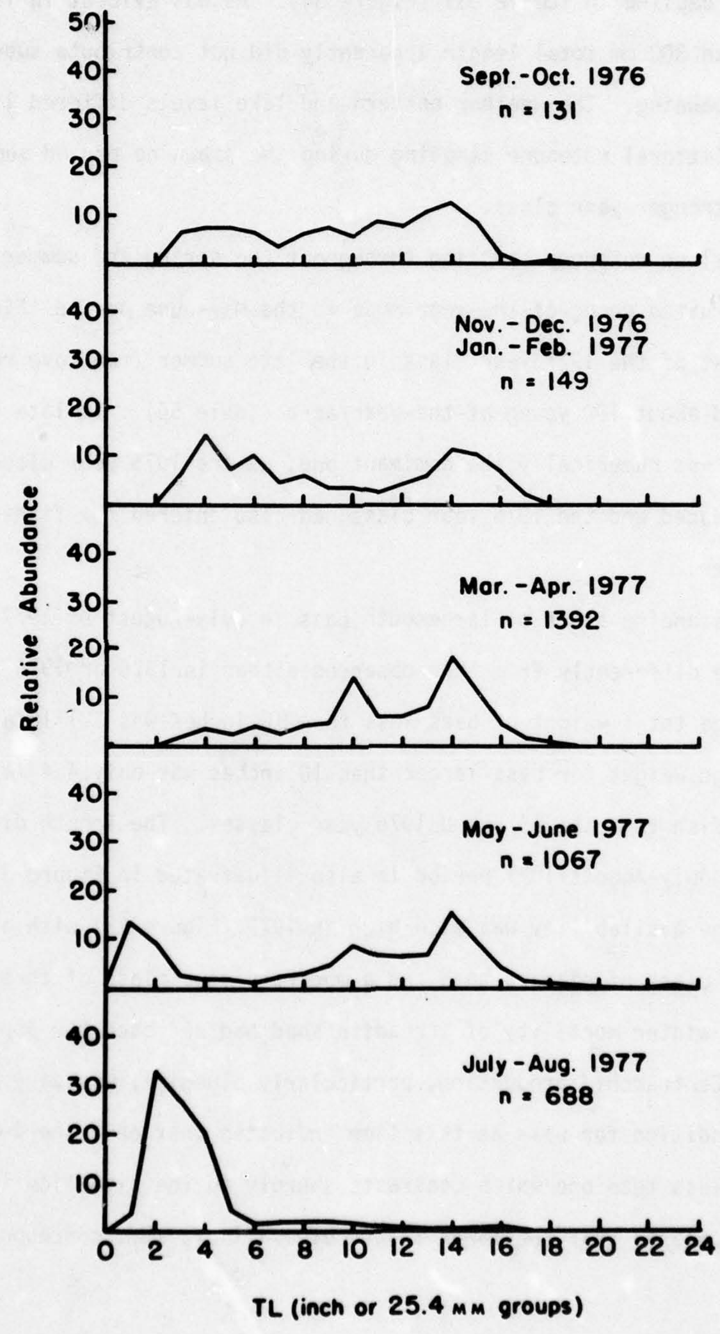

Figure 33. Length frequency of largemouth bass from West Point Reservoir 1976-1977.

242. Spawning in 1977 occurred in the period of late April to May based on the rise and decline in female GSI (Figure 34). As was evident in 1976, females less than 300 mm total length apparently did not contribute substantially to the spawning. The weather pattern and lake levels differed little from 1976, but littoral rotenone sampling during the spawning period suggested a potentially stronger year class.

243. Shoreline rotenone sampling throughout the spring and summer of 1977 defined the recruited young-of-the-year mode in the May-June period (Figure 33). Recruitment of the 1977 year class in the late summer from cove rotenone samples averaged about 100 young-of-the-year/acre (Table 56). In late summer this year class was numerically the dominant one, as the 1975 year class had been greatly reduced and the 1976 year class had also entered the fishery during the summer.

244. The standing stock of largemouth bass in July-August of 1977 was structured quite differently from that observed either in 1975 or 1976 (Table 56). The average total weight of bass less than 10 inches was 3.1 lb/a, but the total average weight for bass larger than 10 inches was only 4.4 lb/a which included fish from the 1975 and 1976 year classes. The length distribution during the July-August 1977 period is also illustrated in Figure 33.

245. Forage availability was also high in 1977 (Figure 29) with a very successful year class of gizzard shad and a moderate year class of threadfin shad. The 1976 winter mortality of threadfin shad had set back the population considerably. Centrarchid production, particularly bluegill, was very high. The relative condition for bass at this time indicated that only the 4-inch group had a Kn less than one which contrasts sharply to the situation in 1975 and 1976. It appeared that the lower length of available shad corresponded to

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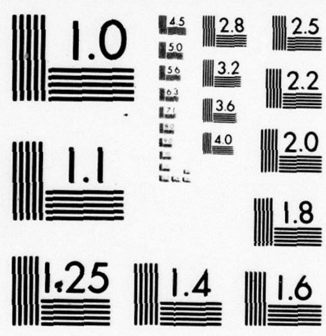

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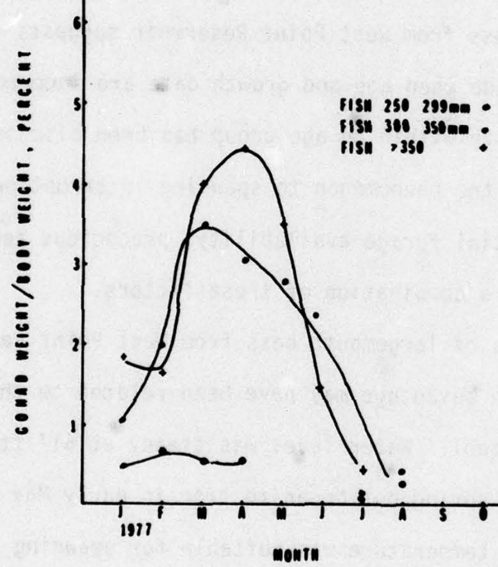


Figure 34. Gonadalsomatic index of female largemouth bass from West Point Reservoir in 1977.

the low Kn for bass even though the deep-bodied prey was relatively abundant (Figure 29).

246. The AP/P plot for 1977 suggests an availability of prey species for bass equivalent at all sizes (Figure 30). Food habits of largemouth bass in 1977 (Figure 35) were generally comparable to the earlier period (1975-1976). More detailed analysis of the smaller bass delineated more precisely the length of initial piscivorous feeding.

247. The variation in growth within a single year class as observed in the 1975 year class of largemouth bass from West Point Reservoir suggests that cautious interpretation should be made when age and growth data are incorporated into population models. Multimodality within an age group has been discussed by various workers who have related the phenomenon to spawning interruption by climatological factors, differential forage availability, precocious tendency to initiate piscivorous feeding, or a combination of these factors.

248. In the initial year class of largemouth bass from West Point Reservoir, the primary cause for a growth advantage may have been related to the spring rise in water level to full pool. Water level was steady at 617 ft msl throughout the winter and early spring but began to rise in early May to reach 635 ft by mid-May. The water temperature was suitable for spawning after mid-April so that spawning could have occurred during this period but optimum conditions for survival were later as the water level rose. If there had been an earlier spawned group, they would have had a growth advantage. However, a distinct bimodal distribution had not developed until late summer even though the condition of the smaller fish had declined.

249. When the two groups were distinguishable, with reference to their size, the availability of prey was definitely limiting for the smaller

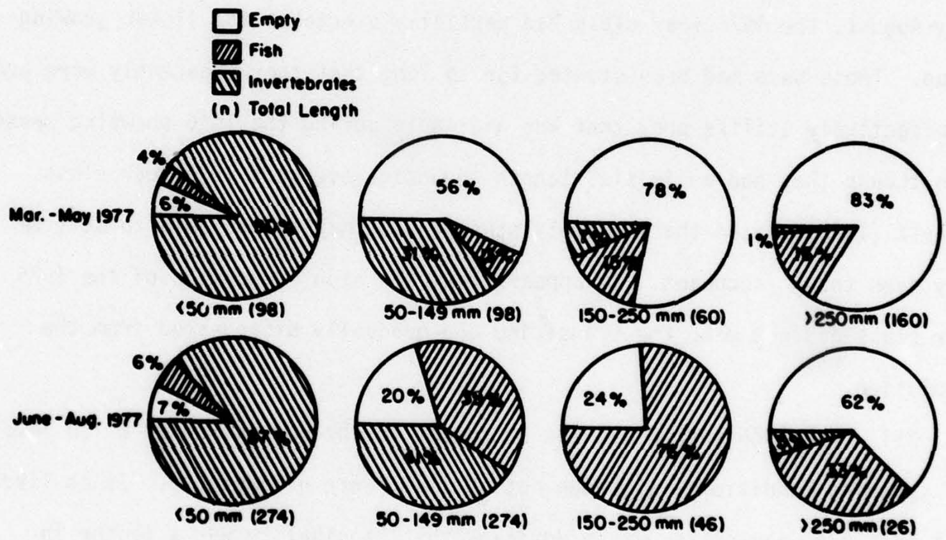


Figure 35. Frequency of occurrence of food items from largemouth bass from West Point Reservoir in 1977.

individuals. As the larger size group continued to grow rapidly, they were able to maintain a length advantage and utilize the prey while the smaller fish grew little and therefore had progressively less prey available to them as time passed.

250. The slower growing group was still evident one year later in May-June 1976, but had grown little. Scale examination confirmed that the 10- to 12-inch mode and the 4- to 5-inch mode were from the same year class. In July-August, the 1976 year class had partially overtaken the slower growing group. These bass had been stunted for so long that they apparently were unable to effectively utilize prey that was available during the 1976 spawning season even though they had an initial length advantage over the 1976 year class. Bennett (1970) stated that severely stunted bass may not be able to utilize prey even though abundant. It appears that the stunted portion of the 1975 year class did not make the transition and gradually disappeared from the population.

251. The 1976 year class was recruited to the population at a low level. The spawning conditions, although not optimal, were not adverse. It is likely that the 1975 year class was so dominant that cannibalism was a factor in reducing the subsequent year class. The slower growing group of the bimodal distribution was small enough (less than 4 to 5 inches) to effectively prey upon young-of-the-year bass. Jenkins (1975) stated that formation of a strong year class of bass is apparently impossible to achieve on consecutive years, largely due to cannibalism.

Other Important Species

252. Black Crappie. Black crappie are considered by fishermen to be excellent game fish; most populations, however, are characterized by a cyclic

nature in their abundance, producing a dominant year class every three to five years. Strong fluctuations in year-class strength create an undesirable boom and bust sequence in the fishery. Black crappie in West Point Reservoir spawned heavily in the spring of 1975 and grew slowly; by August the majority were only 4 inches in length (Figure 36). One year later this population had grown on the average only one inch. Some individuals, however, were in the 6- to 7-inch group and entered the fishery in the spring of 1977. This population reached sexual maturity in 1977 and produced a moderate year class. With recruits now present in the population and the majority of the 1975 year class now being of harvestable size, black crappie should be an important sport fish in the future.

253. The decline in numbers and total weight of black crappie in the population is characteristic of a population changing from a stunted, slow-growing condition to one in better balance with the food supply (E values of 11.5, 5.9, and 1.3 in 1975, 1976, and 1977, respectively). The percentage of harvestable size fish in the population also reflects the changes in population structure (0.3, 10.0, and 11.0 percent in 1975, 1976, and 1977, respectively).

254. Bluegill. Unlike many fish species in the reservoir, bluegill have spawned each year and as a result represent an important source of small size prey in the system. An adequate number of intermediate size bluegill (3 to 5 inches) in the population provide recruits for those harvestable size fish (>6 inches) lost to natural and fishing mortality. The bluegill in the 4- to 7-inch mode in 1975 were probably from the river population. Growth and condition of bluegill in the reservoir are not as good as bluegill from balanced, fertilized farm ponds; this may be attributed to the depauperate benthic community in the reservoir. The annual 10-foot drawdown exposes 7,000 acres of littoral

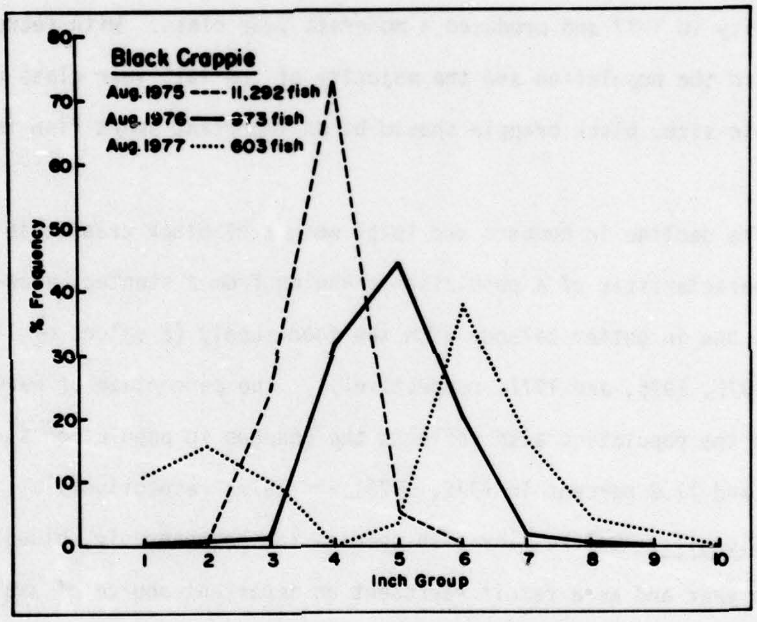


Figure 36. Length-frequency of black crappie in West Point Reservoir in August 1975, 1976, and 1977.

bottom with disturbance of the benthos. Bluegill presently occupy only 5 percent of standing stock, compared to 7.4 and 6.9 percent in 1975 and 1976 (Figure 37).

255. Threadfin Shad. Threadfin shad were not present prior to impoundment and was the only species stocked. Several thousand adults were stocked in 1973 into two watershed reservoirs by personnel of Auburn University and Georgia Dept. of Natural Resources. Some spawning occurred as indicated by young-of-the-year collected in Yellowjacket Creek in 1973. A sufficient number apparently survived from the two stocked areas so that a population developed in the reservoir. The threadfin shad has been characterized as an ideal prey species for largemouth bass; its suitability is dependent upon two major characteristics: 1) it grows to a maximum size (6 to 7 inches) that can be utilized by 12- to 14-inch bass, and 2) it feeds relatively low on the food chain and does not seriously compete with other species.

256. The initial year class, by August of 1975, had a modal length of 4 inches. The population spawned in 1976 and 1977 and in each year expressed a reduced rate of growth compared to the first year (Figure 38). The winter of 1976-77 was severe; the drop in water temperature (<41°F) resulted in extensive mortality. Those surviving members of the 1976 year class had reached a maximum size of 6 inches by August of 1977.

257. The threadfin shad represents only a small percentage of the total standing stock (2.2, 2.9, and 1.3 percent in 1975, 1976, and 1977, respectively). Given a series of mild winters, this species should increase in importance and realize the full potential as an ideal forage with a substantial standing stock.

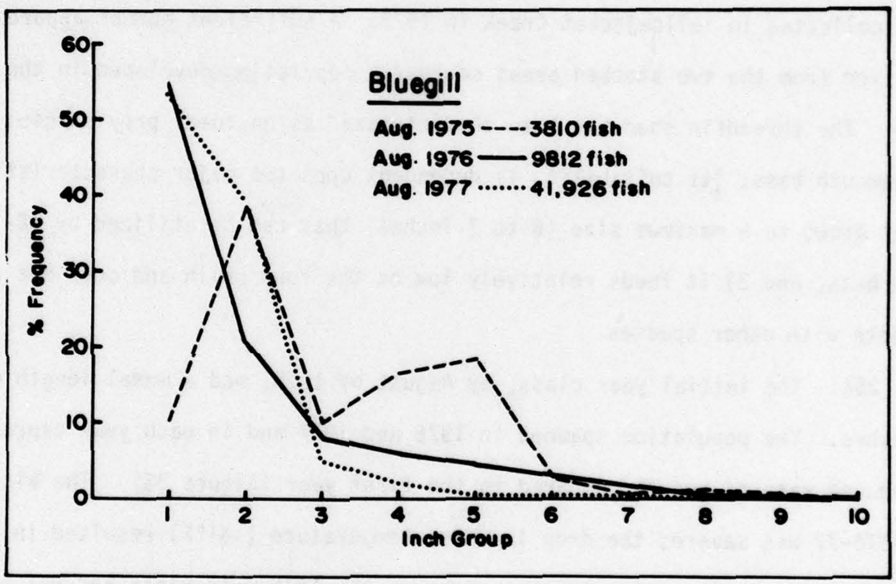


Figure 37. Length-frequency of bluegill in West Point Reservoir in August 1975, 1976, and 1977.

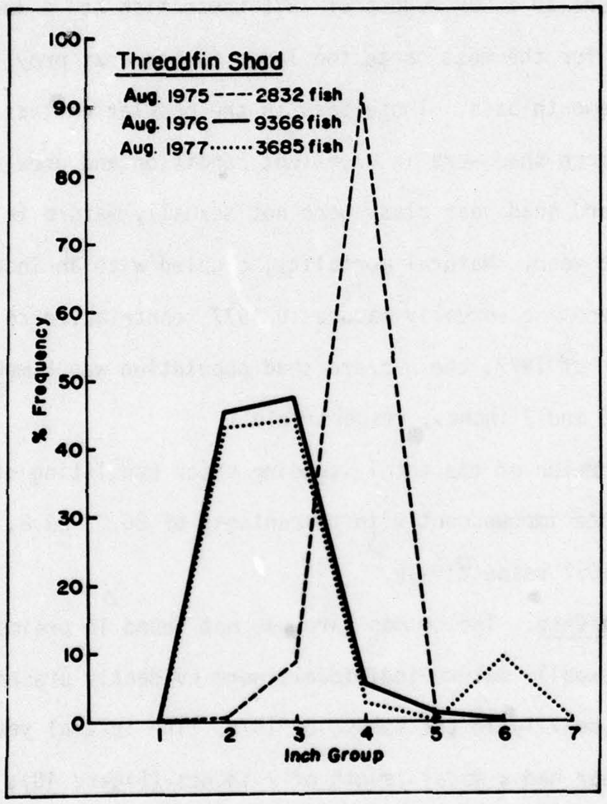


Figure 38. Length-frequency of threadfin shad in West Point Reservoir in August 1975, 1976, and 1977.

258. Gizzard Shad. A large proportion of the gizzard shad population in preimpoundment time consisted of large (>12 inches) sexually mature adults. As expected, these adults spawned heavily in the new reservoir creating a population in 1975 and 1976 consisting of relatively slow-growing, sexually immature individuals (Figure 39). By August of 1975 these fish had a modal length of 4 inches and were, for the most part, too large to serve as prey for many young-of-the-year largemouth bass. Those bass in the population that were able to feed on 4- to 6-inch shad were in excellent condition and grew rapidly. Females of the 1975 gizzard shad year class were not sexually mature in 1976 and few, if any, spawned that year. Natural mortality, coupled with an increased portion of the population becoming sexually mature in 1977, contributed to a successful spawn. In August of 1977, the gizzard shad population was bimodal with two year classes at 6 and 3 inches, respectively.

259. The portion of the total standing stock consisting of gizzard shad has increased since impoundment with percentages of 26.0, 29.8, and 85.3 in 1975, 1976, and 1977 respectively.

260. Common Carp. The common carp was not found in preimpoundment surveys; however, sexually mature individuals were evidently present in the watershed and spawned heavily in the spring of 1975. The initial year class in August of that year had a modal length of 7 inches (Figure 40); in the spring of 1976 males of the 1975 year class were sexually mature, but females were not. No young-of-the-year were evident in the fall cove rotenone samples. In 1977, both males and females of the 1975 year class were sexually mature and spawning did occur as evidenced by spent females collected in late spring. However, in August 1977 very few young-of-the-year were evident. Members of the 1975 year class at this time had a modal length of 14 inches.

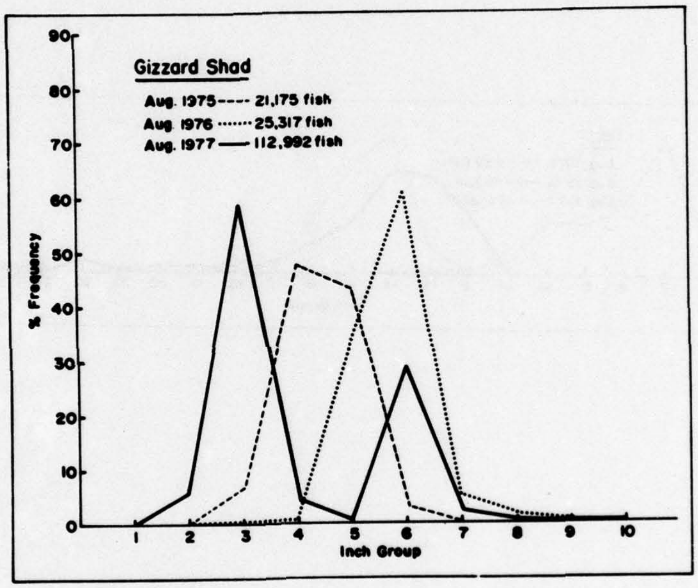


Figure 39. Length-frequency of gizzard shad from West Point Reservoir in August 1975, 1976, and 1977.

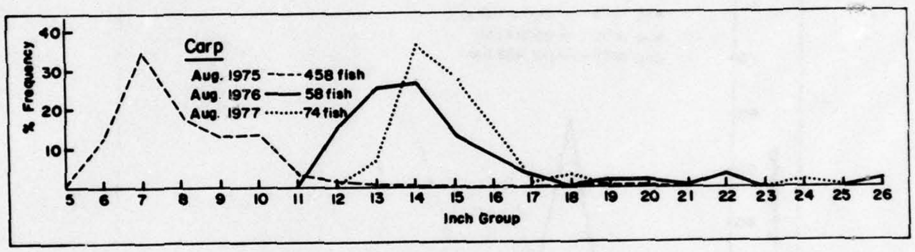


Figure 40. Length-frequency of common carp in West Point Reservoir in August 1975, 1976, and 1977.

261. As in other Southeastern impoundments common carp represent only a small percentage of total standing stock. In West Point Reservoir E values for 1975, 1976, and 1977 were 6.5, 3.9, and 2.9 percent, respectively, indicating that the common carp is declining in importance in the reservoir. Predation by largemouth bass is certainly a factor in controlling the recruitment of common carp. Carp spawn in shallow areas with abundant vegetation; habitat of this type is uncommon in West Point Reservoir. Therefore, the few young that may be produced are more vulnerable to predation and no problem population is expected.

262. Bowfin. Sexually mature bowfin were well represented in the river prior to impoundment and spawned heavily in the spring of 1975. In August young-of-the-year had a modal length of 7 inches (Figure 41). Bowfin are highly piscivorous and undoubtedly compete with young-of-the-year largemouth bass. As with the common carp, however, female bowfin did not become sexually mature until their second year of life. In the fall of 1976, few young-of-the-year were collected. At this time the initial year class ranged in length from 13 to 18 inches. In 1977 the population consisted of a high percentage of sexually mature individuals; however, in August no young-of-the-year were collected in the cove rotenone samples.

263. The bowfin population in 1975, 1976, and 1977 represented only 6.3, 1.2, and 0.2 percent of total standing stock indicating a decline in importance of this species in the ecosystem.

264. Competition with bass may in part be responsible for the low recruitment, but more than likely the lack of availability of shallow, weedy habitat is the major limiting factor, not only for spawning but for protection of young from predation.

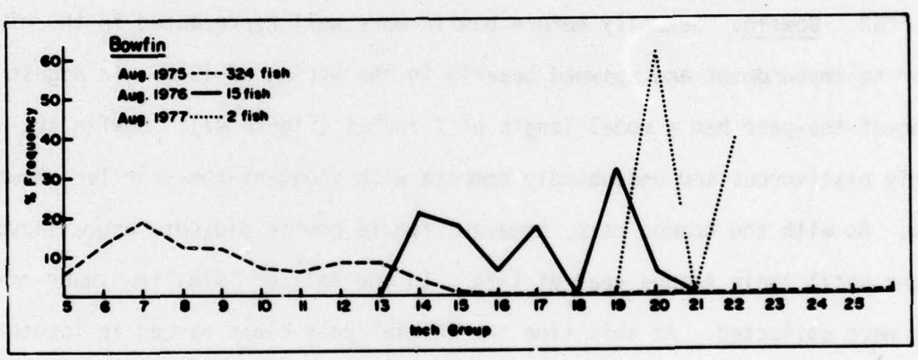


Figure 41. Length-frequency of bowfin in West Point Reservoir during August 1975, 1976, and 1977.

265. Brown Bullhead. Brown bullheads were collected in large numbers in August 1975 (Figure 42). This dominant year class has persisted with little or no recruitment through 1977. Modal length increased from 5 inches in 1975 to 7 inches in 1976 and 1977 indicating a relatively slow rate of growth.

266. Presently brown bullheads represent an insignificant portion of the total standing stock (0.6%) and growth has apparently ceased. Recruitment will probably be minimal due to their vulnerability to bass predation during the fry schooling stage.

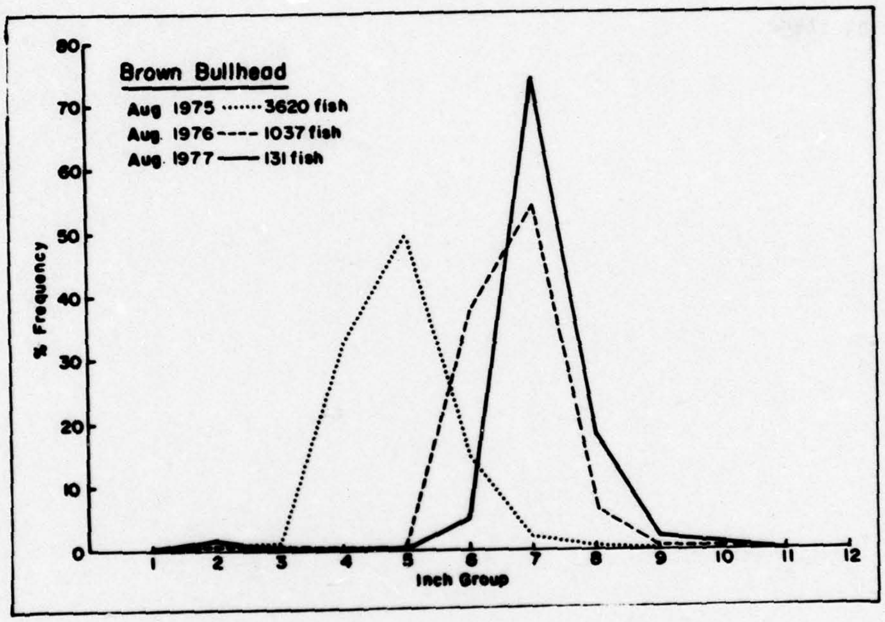


Figure 42. Length-frequency of brown bullhead in West Point Reservoir in August 1975, 1976, and 1977.

Harvest of Fishes

267. Total angler harvest of largemouth bass, black crappie, and bream (bluegill, redear, and redbreast sunfish) and effort (fisherman-hours) as measured from the roving creel survey on West Point Reservoir (February 1976-July 1977) are listed below:

Total Harvest (lb) 1976-1977

Month	Species			Effort	
	Largemouth Bass	Black Crappie	Bream	Bank	Boat
February	12,119	25,954	2,537	21,763	27,293
March	591	0	0	0	1,007
April	33,430	4,145	41,334	121,901	84,333
May	14,076	305	48,230	72,656	95,695
June	19,404	0	31,494	47,091	133,456
July	8,226	0	4,713	23,585	69,929
August	4,142	0	1,012	16,817	26,413
September	26,631	0	1,473	30,057	51,000
October	10,506	2,973	218	14,131	42,608
November	378	5,397	108	8,712	11,697
December	211	59	0	278	3,911
January	0	0	0	458	268
February	0	0	0	685	3,919
March	7,738	136,452	1,459	116,985	225,751
April	17,325	16,458	36,237	66,135	104,280
May	15,149	1,267	53,862	50,932	123,407
June	9,590	3,594	6,419	32,565	70,060
July	12,288	4,282	2,931	16,659	29,281
Total	191,804	200,886	232,027	641,410	1,104,308

268. Catch (lb) per fisherman-hour for bass, crappie, and bream was 0.11, 0.12, and 0.13, respectively. A total effort of approximately 70 fisherman-hours per acre for the 18-month period (43 hr/a/year) represents moderate to heavy use of the fishery resources.

Estimated Rate of Exploitation for the 1975 Year Class of Largemouth Bass

269. Largemouth bass of the 1975 year class were collected from West Point Reservoir by shoreline electrofishing during the months of March-June in 1976 and 1977. When 15 to 30 bass were collected from an area, they were tagged with an 8.5-inch, consecutively numbered spaghetti tag with the inscription "Auburn University." The tag was inserted just below the soft dorsal so as to pass between the neural spines. Only those bass larger than 10 inches were tagged. Tagged fish were then released in the general area they were captured. All areas of the reservoir were electrofished at least once each year.

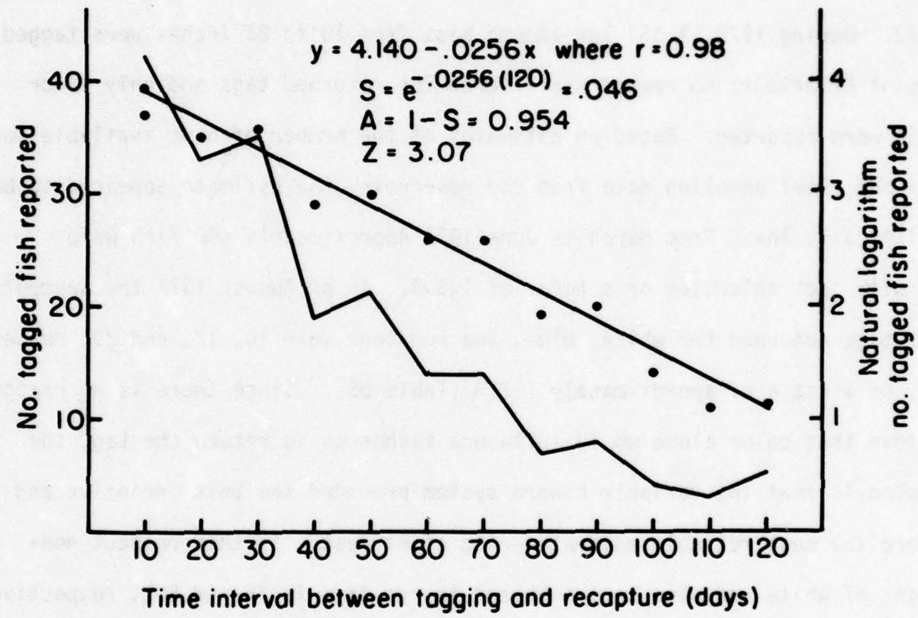
270. In 1976 no rewards were offered for tags returned. Posters depicting a tagged bass with the information requested were placed at each landing and in local stores and bait shops. In addition, project personnel presented programs to various fishing clubs, church groups, and civic organizations within a 100-mile radius of the reservoir. In 1977, the tagging program incorporated a reward system to stimulate the reporting of tags from caught fish. Three different colored tags were used. White tags carried no monetary value, blue tags were valued at $5.00, and red tags had a variable reward ranging from no monetary value to $500.00. For any tag returned, a letter was sent detailing the study with information on when and where the fish was released. New posters illustrating the tag and informing the public of the reward system were placed around the reservoir as in the previous year.

271. Tag loss and mortality associated with the spaghetti tag were initially estimated by stocking 1- to 2-pound bass at a rate of 100/a (one half of which were tagged) in two 0.25-a ponds on the Auburn University Agricultural Experiment Station; bluegills stocked previously provided abundant prey. Bass

were electrofished from bass-bluegill stocked farm ponds on the research station and exposed to the same handling as the reservoir fish. After a 60-day period the ponds were drained; tag loss, determined by comparing the tagged and untagged portion of the populations, varied between 10 and 50%. Additional studies planned in 1978 will document the actual rate of loss, by observing the ratio of tagged and untagged bass in seine samples.

272. During 1976, 1,351 largemouth bass from 10 to 23 inches were tagged in West Point Reservoir; no reward was offered for returned tags and only 78 or about 5% were reported. Based on estimates of the number of bass available for harvest and creel sampling data from the reservoir, the estimate appeared to be unrealistically low. From March to June 1977 approximately 466 fish were marked with each color tag or a total of 1,398. As of August 1977 the percentages of tags returned for white, blue, and red tags were 10, 17, and 29, respectively, or a ratio of approximately 1:2:3 (Table 58). Since there is no reason to believe that color alone would influence fishermen to return the tag, the conclusion is that the variable reward system provided the best incentive and therefore the most reliable estimated rate of harvest. In this respect nonreporting of white and blue tags compared to red tags is 75 and 50%, respectively. The return of white tags in 1977 approximates the return of no-reward tags in 1976.

273. Tagged fish disappeared from the population at a constant instantaneous rate as indicated by the linear regression of log of numbers versus elapsed time (Figure 43). Factors contributing to the loss are fishing (F) and natural mortality (M) as well as tag loss (U). The total instantaneous rate of mortality (Z) along with the "annual" component (A) are contaminated by U as is the estimate of the "apparent" rate of exploitation (u). The reasonably



Note: S = survival rate.

Figure 43. Regression of natural logarithms (no. tagged fish reported) on elapsed time between tagging and recapture for the period March through June.

Table 58

1977 reporting of tagged caught largemouth bass based on tag color as of August.

	Tag Color		
	White	Blue	Red
No. fish tagged	466	468	464
No. tags returned	47	81	138
Percent returned	10	17	29
95% confidence limits for binomial dist.	8-12	15-19	26-32

good fit of the data points associated with linear regression in Figure 43 suggests that tag loss may be expressed as an exponential rate throughout the period. An unbiased estimate of fishing mortality is possible since $F = \frac{uZ}{A}$ where the contamination due to tag loss is concelled out (Ricker 1975). Substituting the best estimate of u (36%) based on the red tag return (Table 59), Z and A fit into the equation

$$F = \frac{0.36(3.079)}{0.95} = 1.167$$

274. The use of the relationship $F = \frac{uZ}{A}$ assumes that fishing and natural mortality occur concurrently within the period. Fishing effort for largemouth bass was substantial and evenly distributed throughout the period (Malvestuto, personal communication) and it was assumed that natural mortality affected the dwindling 1975 year class at a rate proportional to their abundance.

275. An independent estimate of total mortality during the same period was possible by documenting the number of 1975 year class bass present in the creel (Malvestuto, personal communication). The natural log of numbers regressed against time gave Z and A to be 1.80 and 0.83, respectively. The

Table 59

Monthly rate of exploitation (March through August) in 1977 based on returns of red tagged fish.

Month	No. fish tagged	No. returns	Exploitation (%)
March	38	0	0
April	235	25	9
May	191	68	15
June	0	35	9
July	0	6	2
August	0	4	1
		Total	36

adjusted rate of exploitation can be calculated for the population by substituting these values into the previous equation:

$$u = \frac{1.167(0.83)}{1.80} = 0.54$$

276. The effect of a 54% rate of exploitation on the 1975 year class during the period combined with natural mortality has reduced their abundance to the extent that few fish of this year class were being incorporated into the creel after July 1976.

Evaluation of Fish Population Sampling Techniques and Design

Electrofishing

277. Large impoundments contain a wide range of habitats from which fish populations can be sampled. To precisely estimate some characteristics of the population, such as growth, collection sites must be selected that have representative sampling segments of the population. Sampling from one or several reference sites in a reservoir may give more precise estimates of the population characteristics, but without information from samples collected at random from the reservoir, no judgment can be made concerning possible bias in these measurements.

278. Fishery studies usually incorporate a site that is repeatedly sampled (reference) without incorporating the random element in the sampling design. The benefit of sampling at reference sites versus randomly selected sites hinges on the relative precision and consistency of estimates obtained. In this study, growth and total weight of largemouth bass were selected as the parameters to be estimated. The variances associated with these estimates were combined from reference and randomly selected sites to determine the usefulness (increased precision) of incorporating reference sites in a reservoir sampling plan.

279. In July 1975, fish population studies were begun to provide information needed to formulate a fisheries management plan for the reservoir. The reservoir was divided into three zones of about equal area for sampling convenience. An attempt was made to include homogenous habitats within zones; Zone 1 was the southernmost portion of the reservoir nearest the dam; Zone 2 consisted of a major arm which received effluent from a city with a

population of 26,000; and Zone 3 was essentially confined to the old river floodplain. However, Zone 3 data are not included in the present study. A reference site adjacent to the shoreline was selected for each of the zones. The reference site and two randomly selected sites were sampled during each sampling period. Selection of the two random sampling sites was achieved by imposing a grid system (0.25 square mile) on a reservoir map. Grids adjacent to the shoreline were numbered and given equal probability of selection for sampling. Selection of zones was done without replacement, i.e., after each zone was sampled, it was not again considered for sampling until the other zone had been sampled. Samples of bass from reference and random sites were compared for total weight per sample and for rate of growth in weight, as these two units of measurements are basic to other studies concerning food habits, sexual maturity, and the distribution of bass in the reservoir.

280. Bartlett's chi-square test for homogeneity of variances (Steel and Torrie 1960) was applied to variances from regression analyses for Zones 1 and 2 to determine if data from the reference sites had variances significantly different from data from random sites and whether pooled analysis of catch data was a valid procedure. Total weight and mean weight of individual bass were analyzed using analysis of variance and analysis of covariance, respectively. These analyses determined variation in total catch and growth rate of bass within and between the two zones.

281. Growth rate was estimated from mean weight of bass collected, under the assumption that the initial year class of bass in the reservoir was relatively uncontaminated with bass of other year classes, i.e., the bass population in the Chattahoochee River before impoundment or in inundated farm ponds.

282. Total weights of largemouth bass collected per 45-minute collecting period between reference and random sites within the two zones did not differ ($P > 0.05$). In addition, total weights of bass collected per sample were not different between the two zones. Thus there was no evidence to indicate bass were not uniformly distributed between and within the two zones considered. Therefore, any sampled site in the main portion of the reservoir should give an equally satisfactory sample of bass.

283. A comparison of slopes for mean weight of individual bass in the sample regressed against time for reference and random sites within Zones 1 and 2 (Figures 44 and 45) showed no difference in growth rate within either of the two zones ($P > 0.05$). There was no difference in the regressions of mean weight on time between the two zones when sample data from within the zones were combined (Figure 46). Therefore, there was no evidence to indicate that bass grew differently within the main portion of the reservoir during the first year of impoundment.

284. Variances associated with regressions of mean weight on time (Zones 1 and 2) did not differ ($X^2 = 10.2$ and 8.18 with 24 and 21 degrees of freedom, respectively); thus, there was no evidence to indicate an advantage in dividing the lower two thirds of the reservoir into zones or for maintaining a reference area for sampling the largemouth bass population. However, there is the possibility that the population structure of bass and catch of other fish species may vary between (but probably not within) zones. Therefore, one sample taken within a zone should give data just as reliable as the current three samples taken within each zone. Based on this formation, electrofishing effort can be modified to increase efficiency and reduce effort.

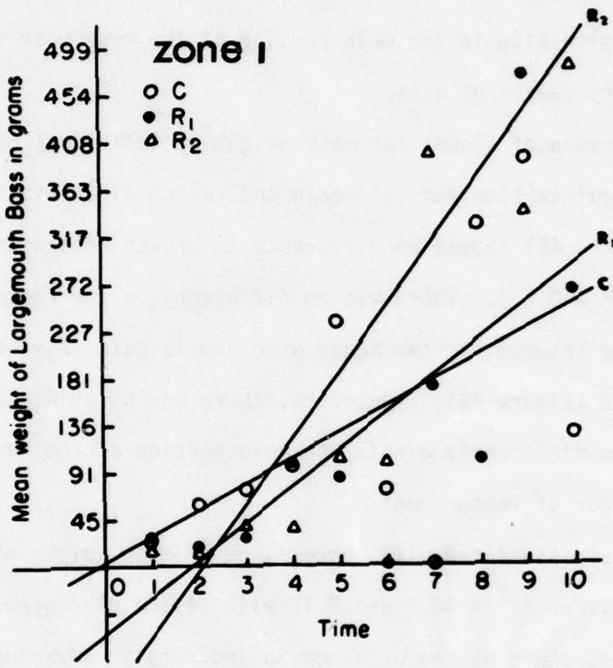


Figure 44. Growth of largemouth bass in control (C) and random (R_1, R_2) sites in Zone 1. Time represents each successive trip to the zone from July 8, 1975, through April 29, 1976. Values of t for regression lines are 2.99, 1.94, and 4.59 and coefficients of determination (R^2) are 0.53, 0.32, and 0.72, respectively. Slopes of lines are not different ($P > 0.05$).

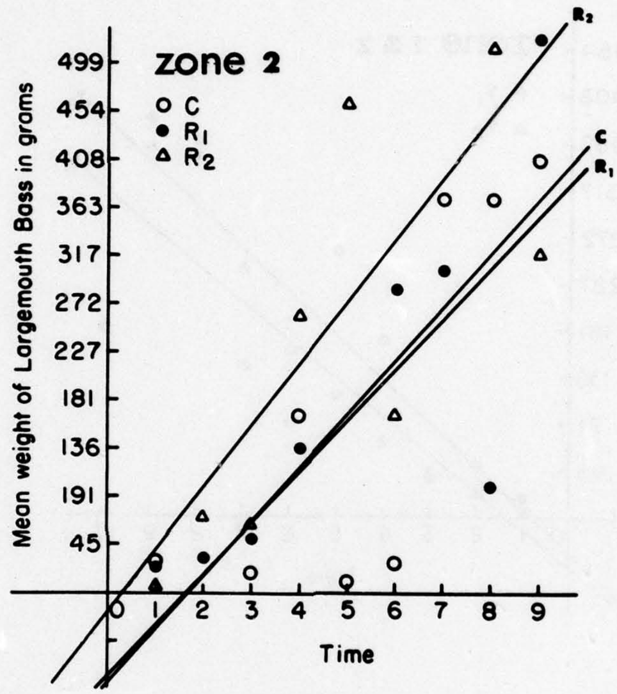


Figure 45. Growth of largemouth bass in control (C) and random (R_1, R_2) sites in Zone 2. Time represents each successive trip to the zone from July 3, 1975, through May 5, 1976. Values of t for regression lines are 2.98, 3.46, and 3.11 and coefficients of determination (R^2) are 0.56, 0.64, and 0.68, respectively. Slopes of lines are not different ($P > 0.05$).

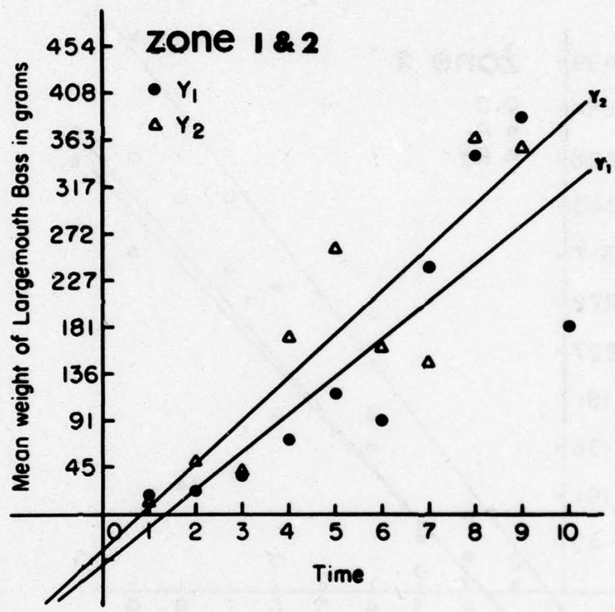


Figure 46. Growth of largemouth bass in Zones 1 (Y_1) and 2 (Y_2). Time represents each successive trip to the zones from July 3, 1975, through May 5, 1976. Values of t for regression lines are 4.19 and 4.86, and coefficients of determination (R^2) are 0.69 and 0.79, respectively. Slopes of lines are not different ($P > 0.05$).

291. There was a significant difference, however ($P < 0.05$), between coves located adjacent to the past river channel and coves in arms of the reservoir away from the river channel. Three coves near the channel averaged 1,310 lbs/a and nine other coves averaged only 233 lbs/a. As a result, cove sampling will be stratified to the extent that coves adjacent to the river channel will be treated separately. The two control coves will be retained to further evaluate the random element versus repeatedly sampled areas.

Modification of the Roving Creel Survey

292. Davies and Shelton (1976) give a detailed description of the roving creel survey design and evaluate the design in terms of its ability to provide unbiased estimates of effort, CPE (catch per unit of effort), and harvest. They also show that the sensitivity of the design, in terms of its ability to detect changes in CPE of largemouth bass, is quite adequate for the purposes of this study. This evaluation provided a basis by which the design could be modified so that the precision of this survey would be maintained while sampling effort was substantially reduced.

293. The primary justification for reduced sampling is that sample size appears to have no effect on the precision of the survey, at least within the range of 5 to 10 sample days per month. Summer sampling can thus be reduced from 10 to at least 5 days per month without impairing the precision of the estimates.

294. The precision of the survey during the winter is in general 2 to 3 times lower than in the summer. This is seemingly due to the irregular fishing effort and catch during the winter as dictated by the vagaries of the weather. To substantially increase winter sampling in order to increase the precision of

winter estimates would not be efficient because only about 10% of the annual total harvest is expected to occur during this part of the year. It is obvious, however, that sampling must be done during the winter to obtain an estimate of winter harvest despite the fact that the precision of this estimate will be low.

295. This report presents a modified survey design based on a minimum of 45 sample days per year rather than the 90 days now used. Initially, however, it would be safer to reduce sampling to 60 days per year. Because the primary interest is in obtaining estimates of harvest, it is logical to allocate seasonal sampling effort proportional to harvest; that is, 10% or 6 days, would be sampled during the winter (November-January) and the remaining 54 sample days would be allocated to the summer season (February-October). The winter fishing pattern begins in November and continues through March, but due to the advent of the early crappie fishery, February and March are included within the more intensely sampled summer period.

296. The low precision of the survey during the winter suggests that it is not profitable to obtain monthly estimates during this part of the year; the 6 sample days (3 weekdays and 3 weekend days) would be randomly chosen from all days within the 3-month period. It is probably desirable, however, to maintain monthly estimates during the summer so that changes in the species composition of the harvest during this 9-month period can be accurately documented. In such a case, 6 sample days (3 weekdays and 3 weekend days) would be randomly chosen each month.

297. This modified creel survey program will provide unbiased annual estimates of harvest while maintaining the relatively high precision (C.V. at approximately 30%) of the survey during the summer fishing season. At the same time, annual creel survey expenditures will be reduced by 33%.

Conclusions

298. The limnological studies summarized in this report are concerned with water quality, plankton populations, and primary productivity (as these factors relate to fish production) in waters of West Point Lake. Secondary factors relating to the above-mentioned studies including rainfall runoff in the Chattahoochee River basin above West Point Dam, lake levels and discharges, and solar radiation are also summarized. All of this information was interpreted relative to its role toward maximum fish production in West Point Lake.

299. Data on water quality indicate that this lake does become chemically stratified during the warmer months. However, except for unusual adverse conditions, approximately 45 percent of the lake volume has maintained optimum water quality characteristics, and another 20 percent has been adequate for the support of aquatic life throughout the first three years of impoundment.

300. During these three years of monitoring a basic concept of the chemical characterisitc of this lake's waters has emerged. Briefly stated, these waters are soft (<20 mg/l $CaCO_3$ hardness) with a pH near 7.0, maintain a low inorganic and organic carbon concentration, and have an adequate but variable nutrient loading (Figure 47). The lake is subject to periodic inflows of runoff waters heavily laden with colloidal clay particles, but much of this material is deposited in the lake.

301. The tailwater characteristics are quite similar to those lake water conditions that exist at the 16-meter depth above the dam. While these tailwaters often do not comply with water quality standards, they have been adequate to support fish life throughout the history of the dam's existence.

302. The numerous attemps to relate various environmental factors to fish production were reviewed by Henderson et al. (1973). No single factor

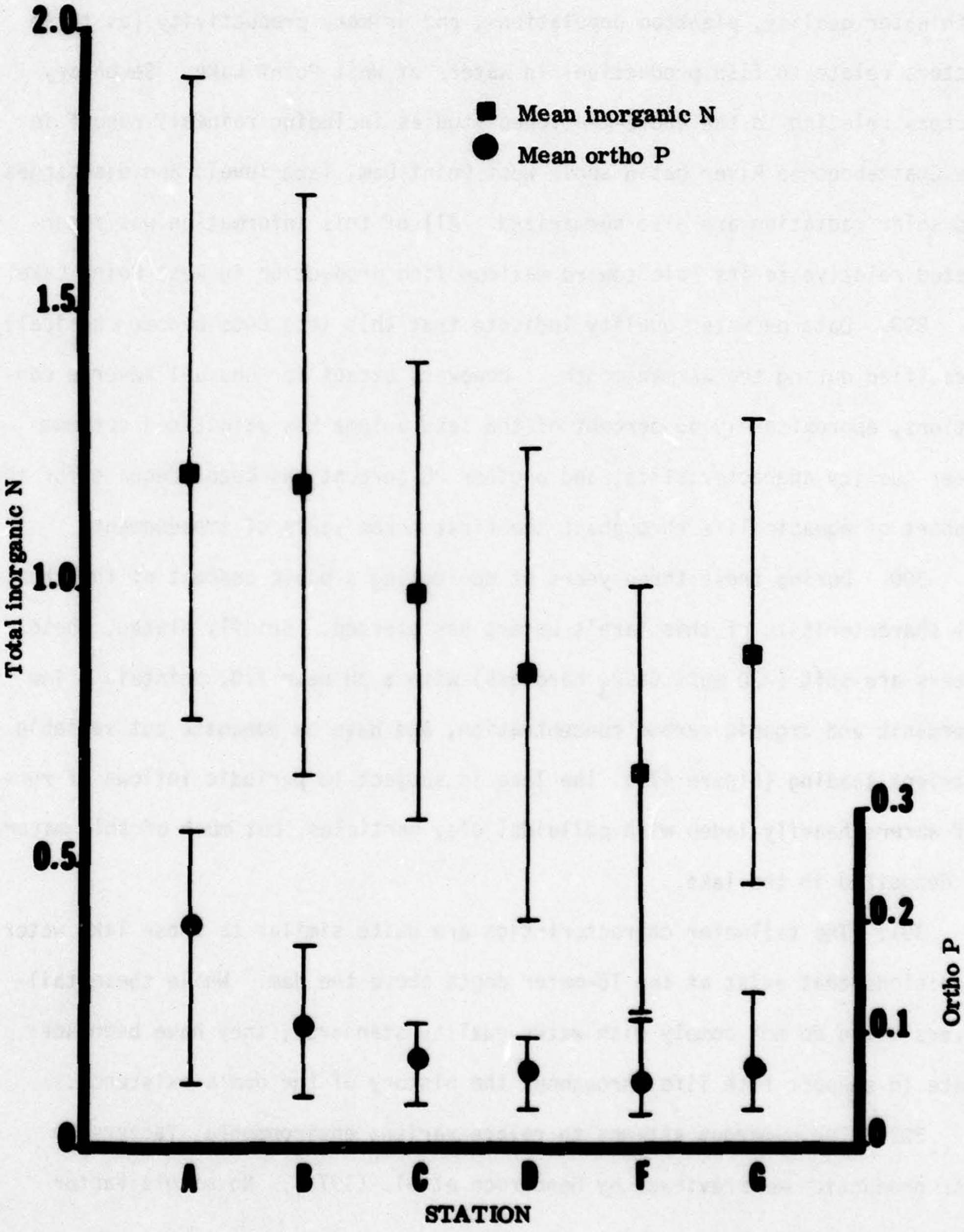


Figure 47. Means and ranges of total inorganic N and ortho P in West Point Lake Waters from January 1976 through September 1977.

explains a significant amount of variation in the fish production, but if more than one variable is considered, the correlation improves considerably (Hayes and Anthony 1964, Jenkins 1967).

303. Ryder et al. (1974) reviewed the use of the morphoedaphic index (Ryder 1965) which incorporates two variables as a predictor of fish yield. These data were primarily for north-temperate lakes, but they did relate it to other latitudes. When they incorporated data from south-temperate reservoirs, for example, they found that there was a considerably higher predicted yield. The general yield estimate for north-temperate lakes was summarized by the relationship of yield $\sim 2\sqrt{MEI}$, where MEI was calculated as total dissolved solids/average depth (feet). The yields for southern reservoirs was about 8 to 10 times greater than the northern lakes.

304. Some of the pertinent morphometric data for West Point Reservoir are summarized in Table 60; average values for 103 U.S. reservoirs (Jenkins and Morais 1971) and 23 southern reservoirs (Campbell et al. 1977) are also included for comparison. Based on the information in Table 60 and the general MEI relationship (MEI = 2.17), the calculated yield for West Point Reservoir is 2.95 lb/a/yr. Fish yield estimated during this study was 26 lb/a/yr or approximately eight times greater than that calculated using the morphoedaphic index method.

305. Jenkins and Morais (1971) discussed the effects of a number of morphometric and physicochemical factors from 103 U.S. reservoirs on standing stock and harvest. The predictive equations have been modified as more data from various categories of reservoirs have become available; the latest multiple regression relationships (1/25/77) from the National Reservoir Program (personal communication) were provided by R. M. Jenkins. The predictions for West Point

Table 60

Morphometric and physicochemical factors for West Point Reservoir and mean values for 103 U. S. reservoirs and 23 southern reservoirs.

	West Point[1]	Southern Reservoirs[2]	U.S. Reservoirs[3]
Surface area (acres)	25,900	13,140	14,600
Average depth (feet)	23	30	55
Maximum depth (feet)	89	-	-
Outlet depth (feet)	68	53	86
Annual fluctuation (feet)	12	9	20
Storage ratio	0.15	0.70	0.88
Shoreline development	23.2	10.9	18.7
Total dissolved solids (mg/l)	50	242	267
Age (years)	2	24	17
Growing season (days)	218	215	189

[1] for 1977.
[2] Campbell et al. 1977.
[3] Jenkins and Morais 1971.

Table 61

Fish population in West Point Reservoir based on various predictive relationships and observed values compared with mean values for 103 U. S. and 23 southern reservoirs.

	Predicted		Observed		
	Jenkins and Morais (1971)[1]	Jenkins (1977)[2]	West Point Reservoir[3]	National Reservoir Sample[1]	Southeastern Reservoirs[4,5]
Standing stock (lb/a)					
Total	177	135	323	-	252
Sportfish	67	62	89.8	-	93
Largemouth bass	-	5.6	15.8	9.8	15.3
Annual Harvest (lb/a)					
Sportfish	22	29	14.4	14.6	18.4
Pounds/hour	-	-	0.33	0.54	0.62
Largemouth bass	-	4.7	3.9	4.0	5.7
Pressure					
Angler-hours/acre	-	43	42.7	30.4	25.8
Angler-days/acre	-	10.9	9.8	6.7	5.9
Hours/angler-day	-	4.0	4.3	4.3	4.4

[1] Jenkins and Morais 1971
[2] Jenkins, personal communication
[3] For the period July 1976 - June 1977
[4] Campbell et al. 1977
[5] Observed standing crop data - Grinstead et al, in press

Reservoir based on the two sets of formulae are compared in Table 61 and can be related to the observed values for West Point and other U.S. reservoirs.

306. Relating biological features to fish production has been reported by several workers (Hibacek 1969, Melack 1976, McConnell et al. 1977). The correlations of these relationships are quite variable and are affected by the separation of the measured variable and the position in the food chain of the fish species.

307. Based on certain chemical and biological parameters measured during the course of this study, West Point Reservoir should be classified as a meso-eutrophic body of water (Table 62). When compared with data from other southeastern reservoirs, it appears likely that nitrogen and phosphorus levels of West Point waters were sufficient to support higher standing crops of chlorophyll a and greater primary productivity.

308. The relationship of phytoplankton productivity to fish biomass in some southeastern reservoirs is presented in Table 63. West Point Reservoir ranks second in estimated fish standing crop behind Walter F. George Reservoir, an impoundment on the same river that for the past 10 to 12 years has supported one of the finest black bass fisheries known. Kentucky Reservoir, the only other mainstream impoundment, ranked first in primary productivity, but had a lower estimated fish standing crop (Table 63). There seems to be an efficient transfer of organic materials through the food web resulting in relatively high fish biomass in West Point Reservoir.

309. Fisheries studies dealt primarily with the population dynamics (growth, recruitment, and mortality) and harvest of important fish species in the reservoir. In addition, a discussion of preimpoundment fish populations was included for completeness. These data were analyzed to provide a baseline of

Table 62

Trophic relationships of three southeastern reservoirs.

Trophic Type[a]	Mean net primary productivity ($mgC/m^2/day$)	Chlorophyll a (mg/m^3)	Total Carbon (mg/l)	Total organic carbon (mg/l)	Total P (µg/l)	Total N (µg/l)
Oligotrophic	50-300	0.3-3	-	<1-3	1-5	1-250
Mesotrophic	250-1,000	2-15	-	<1-5	5-30	250-1,100
Eutrophic	>1,000	10-500	-	5-30	30->5,000	500->15,000
RESERVOIR						
Walter F. George	-	7-12[b]	11-17	-	34-65[b]	709-939[b]
West Point	689	6-19	6-11	5-10	209-234	1,106*
Beech[c]	1,619	3-25	-	-	-	800

[a]Wetzel, R. G. 1975. Limnology. W. B. Saunders Co. Philadelphia. 743 pp.

[b]E.P.A. 1975. Preliminary report on Walter F. George Reservoir. E.P.A. Nat'l. Eutrophication Survey. NERC, Las Vegas, NV.

[c]Taylor, M. P. 1972. Seasonal plankton changes and primary productivity in Beech Reservoir. J. of the Tenn. Acad. of Sci. 47(3): 103-111.

*Inorganic N.

Table 63

Relationship of phytoplankton productivity to fish biomass (based on rotenone samples) in some southeastern reservoirs.

Reservoir	Reservoir type	FISH Standing crop rank	FISH kg/ha	FISH years sampled	PHYTOPLANKTON Productivity rank	PHYTOPLANKTON $mg\ C/m^2/day$
Walter F. George[a]	mainstream	1	382	1963, 64, 65, 66, 67	-	-
West Point	mainstream	2	350*	1975, 76, 77	4	689
Kentucky[b]	mainstream	3	280	1952, 63, 64	1	1,443
Cherokee[b]	storage	4	230	1963	2	1,416
Norris[b]	storage	5	150	1941, 60, 61	5	360
Nottely[b]	storage	6	143	1961, 64, 65	6	208
Douglas[b]	storage	7	125	1961, 65	3	943
Beech[b]	tributary	-	-	-	-	1,619

[a]Lawrence, J. M. 1974. Walter F. George Lake. The design memorandum. The master plan. Appendix D. Fish management plan. U.S. Army Engineer District, Mobile. Corps of Engineers. Mobile, AL.

[b]Taylor, M. P. 1971b. Phytoplankton productivity response to nutrients correlated with certain environmental factors in six TVA reservoirs. Pages 209-217 in G.E. Hall, Ed. Reservoir fisheries and limnology. Amer. Fish. Soc.

*Excluding one 1977 cove sample in which over a ton of shad per acre were recovered.

information on which to formulate management recommendations in the future and to improve on efficiency of sampling effort in large impoundments.

310. Preimpoundment fishery studies revealed the presence of 53 species representing 14 families. Three Apalachicola endemic species were collected in the study area; these are not considered endangered or threatened.

311. Fish populations during the first 30 months of impoundment were dominated by the strong year classes produced in the spring of 1975. The resulting growth and recruitment has affected the patterns and intensity of sport fishing on the reservoir. Largemouth bass from the initial spawn first entered the fishery one year later. This year class essentially supported the fishery for approximately 18 months until the somewhat slower growing (and less numerous) 1976 year class reached the Georgia legal limit of 12 inches. The harvest of largemouth bass, bream, and black crappie when compared with other reservoirs (Table 61) illustrates the relative intensity of fishing pressure and relative success rate.

312. Total harvest was influenced by the size and age structure of the "fished-for" species. In each of the populations during this period harvestable size fish were mainly fast-growing members of the 1975 year class. Competition for food both between and within species, however, limited the number of fish available for harvest.

313. The harvest of largemouth bass alone (3.9 lb/a) must represent a high rate of exploitation as judged by the rate of tag returns. A 50% rate of exploitation in a system of moderate fertility and on the initial year class of an expanding bass population has altered the size composition of the population and thus in the creel. The average size bass in the creel increased from 1.0 lb in February 1976 to approximately 2.2 lb in the spring of 1977. At this point

fewer and fewer 1975 year class bass were entering the creel until, in July 1977, the majority of bass being caught were from the 1976 spawn and averaging only 1.1 lb. The result is not "overfishing" in the classical sense in that the reproductive potential of the population has been hindered. Exploitation has, however, restructured the size composition so that the majority of the fish harvested will be small. This altered size structure affects the quality of fishing, if size is an important criterion, but perhaps equally important is that the predator-prey relationship is unbalanced. The larger bass that could utilize plankton-feeding shad have been removed from the system. Therefore, the potential sport fish productivity is reduced as shad stockpile at a size too large to be utilized as prey.

314. Based on findings to date, the lack of cover is a probable factor in spawning/year class survival. In future reservoir construction it would seem advisable to exercise more control on the clearing operation so that some structure is left. The removal of trees below ground level destroys the valuable stumps that could serve as cover for many years. The added expense incurred from a less mechanized clearing operation could pay dividends to the fishery. For example, stumps might be left in selected coves in addition to standing tree shelters.

315. With reference to the existing conditions, and with the limited capability for flooding terrestrial vegetation above normal summer pool in West Point Reservoir, it is suggested, for consideration, that a planned water level program be adopted to encourage terrestrial plant development during a controlled drawdown. If feasible and operationally safe, perhaps a summer pool of 630 ft msl for a complete year would permit plant growth that could be safely flooded the next year. This would improve the probability of a strong year class of bass and might be repeated on a 3- to 4-year cycle.

316. Other management considerations for the future may include 1) stocking alternate species for harvest or as readily available prey, and 2) regulation of exploitation. The exact form of these recommendations will, of course, depend upon the results of continued studies on the reservoir.

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APPENDIX

Appendix Table 1

Hydrological and meterological data for West Point Reservoir study, May 1975 - September 1977.

Year	Month	Inflow [1] (cfs)	Discharge [2] (cfs)	Lake Elevation [2] (msl)	Rainfall [3] (inches)	Solar Radiation [4] (Langleys)
1975	May	5,932	2,404	629.0	3.46	11,963
	June	3,877	5,072	634.7	6.85	13,685
	July	3,213	4,358	635.0	6.51	11,198
	August	3,724	5,186	634.7	4.37	12,997
	September	3,209	4,112	634.2	-	9,380
	October	4,030	6,754	634.9	6.03	9,764
	November	3,981	6,698	631.7	3.03	7,322
	December	4,144	6,458	626.1	5.79	4,423
1976	January	7,292	8,550	626.7	4.62	4,611
	February	5,137	8,369	626.9	1.88	8,904
	March	9,541	12,260	629.9	11.75	8,383
	April	8,675	8,730	632.7	3.32	16,037
	May	6,932	8,038	635.0	7.95	15,134
	June	5,921	7,470	635.3	4.92	14,867
	July	4,810	6,028	634.6	2.67	16,373
	August	3,328	4,039	632.4	1.82	15,838
	September	2,688	3,429	631.3	5.06	12,291
	October	4,030	2,376	630.7	4.96	10,061
	November	3,981	3,239	631.4	4.59	7,785
	December	4,144	6,016	627.9	6.17	6,810
1977	January		5,187	626.1	4.40	7,308
	February		3,275	626.0	2.16	10,243
	March		8,783	630.2	10.42	10,762
	April		11,876	630.8	2.70	15,809
	May		4,475	634.9	0.85	16,740
	June		3,333	634.3	3.61	17,557
	July		3,757	632.5	4.25	16,156
	August		3,958	631.5	4.78	14,941
	September		2,405		-	10,903

[1] Inflow USGS Gaging Station, Whitesburg, Georgia.

[2] Lake levels and discharge Powerhouse of West Point Reservoir.

[3] Rainfall accumulations NOAA, National Weather Station, LaGrange, Georgia.

[4] Continuous Solar Radiation NOAA, National Weather Service Station, Auburn, Alabama.

Appendix Table 2

Mean turbidities (JTU's) of West Point Lake at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	A	B	C	D	F	G	E
					mg/l			
1	0				3.4			
	2				5.0			
	8				5.3			
2	0		20.0	18.0	17.0			
	2		23.0	18.5	17.0			
3	0		17.15	18.5	12.60			
	4		22.0	20.9				
	8				9.76			
	12-16			20.9	12.00			
	24				20.00			
4	0	45.66	11.02	2.55	1.97	4.60	2.70	3.85
	2	19.00	7.75	2.15	1.50			
	4		17.50	1.90	1.93			
	8		25.66	5.20	2.20			
	16			22.16	15.66			
	24				12.93			
5	0	17.00	8.00	3.60	2.30	2.00	2.80	4.50
	2	29.00	8.20	2.90	1.80	2.30	2.50	
	4		9.60	3.10	2.00	2.10	2.80	
	8		14.50	4.10	2.70			
	12-16		21.00	10.00	3.50			
	24				14.00			

Appendix Table 3

Mean suspended matter concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	A	B	C	Station D	F	G	E
					mg/1			
1	0				1.700			
	2				1.440			
	8				0.780			
2	0		7.550	4.550	1.680			
	2		9.980	2.790	1.950			
3	0		11.270	4.460	5.506			
	4		28.060	12.190				
	8				8.980			
	12-16			23.320	8.970			
	24				22.440			
4	0	36.970	5.265	2.297	1.777	3.560	2.210	3.850
	2	20.860	5.660	2.745	1.200			
	4		10.986	2.885	1.213			
	8		19.640	3.196	0.670			
	16			20.450	12.126			
	24				7.086			
5	0	22.220	7.020	2.670	1.450	2.590	2.820	3.650
	2	60.080	7.620	2.000	1.300	1.590	2.460	
	4		7.840	2.780	1.140	1.720	2.180	
	8		11.600	3.840	1.880			
	12-16		24.520	7.920	2.550			
	24				10.300			

Appendix Table 4

Mean pH's of West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	A	B	C	Station D	F	G	E
					mg/1			
1	0				6.25			
	2				6.40			
	8				6.50			
2	0		6.85	6.98	6.52			
	2		6.89	6.68	6.55			
3	0		8.18	7.58	8.63			
	4		8.45	6.93				
	8				6.49			
	12-16			6.65	6.55			
	24				6.63			
4	0	6.98	7.28	7.78	7.51	7.0[illegible]	7.60	6.86
	2	7.08	7.13	7.23	7.42			
	4		6.91	7.11	7.18			
	8		6.90	6.84	7.06			
	16			6.85	6.70			
	24				6.79			
5	0	6.75	7.18	7.75	7.35	7.12	7.25	6.93
	2	6.85	7.04	6.95	6.90	7.15	7.03	
	4		6.98	6.85	6.75	6.84	6.82	
	8		6.95	6.69	6.67			
	12-16		6.93	6.75	6.68			
	24				6.73			

Appendix Table 5

Mean umhos (specific conductance) of West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	A	B	C	D	F	G	E
					umhos			
1	0				40.8			
	2				38.9			
	8				38.5			
2	0		58.1	40.8	52.1			
	2		58.2	40.8	50.0			
3	0		59.3	52.6	56.0			
	4		61.4	52.9				
	8				53.2			
	12-16			61.4	49.5			
	24				58.8			
4	0	78.5	62.0	58.2	54.9	51.3	50.0	65.6
	2	62.5	57.3	56.9	53.2			
	4		69.6	60.1	55.6			
	8		64.5	59.9	53.6			
	16			73.3	70.7			
	24				87.3			
5	0	50.0	50.0	50.0	50.0	50.0	44.4	55.6
	2	47.6	50.0	50.0	50.0	44.4	44.4	
	4		50.0	50.0	44.4	44.4	50.0	
	8		57.1	50.0	50.0			
	12-16		50.0	57.1	50.0			
	24				50.0			

Appendix Table 6

Mean free carbon dioxide concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	A	B	C	D	F	G	E
					mg/l			
1	0				2.42			
	2				2.70			
	8				1.76			
2	0		1.54	1.10	1.87			
	2		1.54	1.87	2.09			
3	0		0.55	0.44	0.18			
	4		0	1.10				
	8				3.34			
	12-16			3.30	2.20			
	24							
4	0	1.25	0.60	0.38	0.44	1.04	0.55	2.20
	2	1.10	1.38	0.82	0.60			
	4		1.61	0.88	0.88			
	8		1.79	1.90	1.21			
	16			2.82	3.55			
	24				3.83			
5	0	1.32	1.10	1.10	0.55	0.77	0.77	2.31
	2	1.21	1.10	1.43	1.21	0.88	1.65	
	4		1.43	1.87	1.65	1.76	2.64	
	8		1.65	2.20	2.20			
	12-16		1.54	1.98	1.90			
	24				2.20			

Appendix Table 7

Mean total alkalinity, expressed as ppm $CaCO_3$, concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	A	B	C	D	F	G	E
					mg/l			
1	0				11.00			
	2				10.75			
	8				11.25			
2	0		15.25	17.50	13.00			
	2		15.50	16.25	12.75			
3	0		16.25	17.25	15.58			
	4		18.50	15.75				
	8				16.83			
	12-16			23.50	15.75			
	24				26.00			
4	0	15.16	15.75	17.81	17.93	17.12	17.50	21.37
	2	16.00	15.12	18.00	20.50			
	4		17.16	18.37	18.16			
	8		18.25	17.66	20.12			
	16			27.25	27.83			
	24				33.58			
5	0	13.50	15.75	17.00	16.25	17.50	21.50	15.75
	2	13.75	15.50	17.50	16.50	17.50	21.00	
	4		15.75	17.50	15.50	17.50	20.50	
	8		16.00	16.75	15.00			
	12-16		16.25	17.00	15.50			
	24				16.75			

Appendix Table 8

Mean total inorganic nitrogen (NH_3 + NO_2 + NO_3 forms) concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	A	B	C	D	F	G	E
					mg/l			
1	0				0.627			
	2				0.644			
	8				0.606			
2	0		1.096	0.159	0.818			
	2		1.199	0.286	0.861			
3	0		2.619	0.186	0.098			
	4		1.019	0.215				
	8				0.274			
	12-16			0.140	0.252			
	24				1.210			
4	0	2.096	1.715	0.976	0.746	1.318	0.956	0.606
	2	3.635	0.958	0.921	0.481			
	4		1.241	1.009	0.534			
	8		1.126	0.958	0.428			
	16			0.910	0.733			
	24				1.017			
5	0	0.884	0.927	0.698	0.654	0.322	0.197	0.706
	2	0.867	0.919	0.705	0.687	0.318	0.234	
	4		0.952	0.879	0.709	0.252	0.443	
	8		0.932	0.862	0.691			
	12-16		0.966	0.892	0.679			
	24				0.750			

Appendix Table 9

Mean ammonia nitrogen concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	A	B	C	D	F	G	E
					mg/l			
1	0				0.350			
	2				0.300			
	8				0.780			
2	0		0.640	0.110	0.450			
	2		0.615	0.185	0.350			
3	0		0.135	0.075	0.090			
	4		0.105	0.050				
	8				0.066			
	12-16			0.095	0.170			
	24				1.195			
4	0	0.633	0.242	0.359	0.220	0.370	0.110	0.307
	2	0.400	0.162	0.160	0.133			
	4		0.270	0.225	0.202			
	8		0.261	0.351	0.147			
	16			0.446	0.473			
	24				0.746			
5	0	0.180	0.190	0.120	0.230	0.180	0.150	0.190
	2	0.190	0.215	0.100	0.220	0.190	0.160	
	4		0.215	0.260	0.206	0.165	0.175	
	8		0.195	0.213	0.203			
	12-16		0.230	0.212	0.175			
	24				0.193			

Appendix Table 10

Mean nitrate nitrogen concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	Station A	B	C	D	F	G	E
					mg/l			
1	0				0.277			
	2				0.344			
	8				0.236			
2	0		0.446	0.046	0.358			
	2		0.576	0.100	0.504			
3	0		2.481	0.110	0.006			
	4		0.900	0.150				
	8				0.184			
	12-16			0.037	0.07[illegible]			
	24				0			
4	0	1.426	1.452	0.610	0.525	0.945	0.840	0.295
	2	3.200	0.775	0.750	0.345			
	4		0.943	0.770	0.330			
	8		0.850	0.600	0.275			
	16			0.450	0.253			
	24				0.260			
5	0	0.689	0.720	0.572	0.421	0.142	0.045	0.504
	2	0.663	0.690	0.599	0.452	0.128	0.072	
	4		0.720	0.613	0.493	0.086	0.263	
	8		0.722	0.640	0.473			
	12-16		0.712	0.674	0.497			
	24				0.548			

Appendix Table 11

Mean total inorganic phosphorus concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	A	B	C	D	F	G	E
					mg/l			
1	0				0.042			
	2				0.038			
	8				0.030			
2	0		0.193	0.035	0.065			
	2		0.176	0.035	0.067			
3	0		0.104	0.035	0.028			
	4		0.114	0.042				
	8				0.044			
	12-16			0.053	0.056			
	24				0.152			
4	0	0.149	0.073	0.019	0.012	0.015	0.026	0.035
	2	0.215	0.072	0.027	0.020			
	4		0.107	0.026	0.019			
	8		0.065	0.029	0.023			
	16			0.054	0.064			
	24				0.077			
5	0	0.590	0.272	0.402	0.177	0.081	0.137	0.092
	2	1.005	0.259	0.357	0.090	0.100	0.092	
	4		0.222	0.349	0.105	0.120	0.100	
	8		0.227	0.331	0.090			
	12-16		0.265	0.390	0.086			
	24				0.117			

Appendix Table 12

Mean orthophosphorus concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	A	B	C	Station D	F	G	E
					mg/l			
1	0				0.021			
	2				0.019			
	8				0.015			
2	0		0.135	0	0.035			
	2		0.100	0.100	0.040			
3	0		0.032	0.008	0.002			
	4		0.020	0				
	8				0.010			
	12-16			0.003	0.020			
	24				0.110			
4	0	0.108	0.037	0.005	0.003	0.004	0	0.021
	2	0.215	0.044	0.010	0.007			
	4		0.079	0.008	0.009			
	8		0.029	0.012	0.016			
	16			0.016	0.041			
	24				0.052			
5	0	0.200	0.050	0.040	0.050	0.021	0.030	0.020
	2	0.165	0.079	0.034	0.040	0.030	0.030	
	4		0.082	0.059	0.055	0.020	0.038	
	8		0.120	0.059	0.050			
	12-16		0.095	0.040	0.034			
	24				0.037			

Appendix Table 13

Mean particulate phosphorus concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	A	B	C	Station D	F	G	E
					mg/l			
1	0				0.021			
	2				0.019			
	8				0.015			
2	0		0.058	0.035	0.030			
	2		0.076	0.025	0.027			
3	0		0.071	0.027	0.025			
	4		0.094	0.042				
	8				0.034			
	12-16			0.050	0.036			
	24				0.042			
4	0	0.061	0.048	0.018	0.012	0.011	0.026	0.027
	2		0.055	0.034	0026			
	4		0.043	0.037	0.015			
	8		0.054	0.024	0.015			
	16			0.057	0.035			
	24				0.037			
5	0	0.390	0.222	0.362	0.127	0.060	0.107	0.072
	2	0.840	0.180	0.323	0.050	0.070	0.062	
	4		0.140	0.290	0.050	0.100	0.062	
	8		0.107	0.272	0.040			
	12-16		0.170	0.350	0.052			
	24				0.080			

Appendix Table 14

Mean chloride concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	Station A	B	C	D	F	G	E
					mg/l			
1	0							
	2							
	8							
2	0							
	2							
3	0							
	4							
	8							
	12-16							
	24							
4	0	20.4	16.4	15.8	14.5	9.4	11.0	15.1
	2	24.9	18.3	19.5	14.7			
	4		21.6	20.4	16.5			
	8			18.3	15.1			
	16			20.4	18.5			
	24				18.1			
5	0	7.8	17.0	12.8	9.6	21.3	15.3	20.2
	2	8.2	17.0	9.9	17.7	13.5	15.3	
	4		14.9	14.2	16.0	13.8	17.7	
	8		15.3	16.0	18.8			
	12-16		15.3	17.0	20.2			
	24				21.3			

Appendix Table 15

Elemental content in filtered water and suspended matter from West Point Lake on various dates in 1974, 1975, 1976, and 1977.

			Ca		Mg		K		Fe		Mn		Cu		Zn	
Station	Date	Depth	H_2O	SM	H_2O	SM	H_2O	SM	H_2O	SM	H_2O	SM	H_2O	SM	H_2O	SM
								mg/l								
A	7- 1-75	0	2.10	.060	1.20	.104	2.00	135	.200	4.050	0	.058	.020	004	.160	.080
	8- 5-75	0	2.90	0.48	2.53	.193	2.34	.157	0	6.300	.030	.049	0	.007	.950	.600
		1	3.00	.038	2.50	.205	2.34	.186	0	6.600	.050	.047	0	.004	.650	.072
	3-16-77	0	1.65	.260	2.52	.042	0.55	.040	.065	0.360	.200	.088	.017	0	0	0
		0	1.52	.190	2.40	.034	0.55	.040	.036	0.382	.100	.088	.060	.003	0	0
		2	1.54	.120	2.28	.045	1.03	.040	.065	0.302	.200	.122	.067	0	0	0
		2	1.77	.086	2.36	.042	0.88	0	.133	0.132	.200	.200	.068	0	0	0
B	3-12-75	0	1.34	0	2.03	.045	1.28	.082	0	2.500	0	.012	.060	0	0	.054
		2	1.34	.003	1.99	.094	1.12	.112	.185	2.800	.013	.018	0	0	0	.056
	5-24-75	0	1.84	.024	24.00	.033	0.50	.015	0	2.300	.040	.044	0	.001	0	.007
		0	1.84	.032	20.00	.066	1.30	.010	0	2.700	0	.046	0	.001	0	.010
	5-26-75	0	1.74	.024	10.00	.034	1.30	.010	0	1.000	.120	.040	0	0	0	.008
	6-20-75	0	2.60	.080	1.24	.090	1.20	.040	0	3.650	0	.194	.020	.010	0	.220
		6	2.90	.080	1.35	.114	1.00	.055	0	5.000	0	3.000	.020	.022	0	1.300
	7- 1-75	0	2.45	.025	1.41	.030	1.68	.015	0	0.480	.080	.062	0	.002	0	.056
		4	2.45	.010	1.40	.032	1.68	.065	0	1.005	.080	.066	0	0	0	.040
		8	2.75	.015	1.62	.025	1.05	.015	.200	0.150	.080	.090	0	.006	.060	.041
	8- 5-75	0	2.30	.038	2.00	.062	1.86	.058	0	1.550	.030	.034	0	.005	.650	.080
		1	2.20	.020	2.70	.061	2.18	.040	0	1.550	.050	.034	0	.002	.780	.032
		2	2.10	.020	2.05	.045	2.00	.040	0	1.900	.050	.034	0	.007	.390	.045
		4	2.60	.020	2.25	.070	2.18	.073	0	4.060	.030	.090	0	.017	.320	.052
		8	2.50	.030	2.20	.096	1.86	.103	0	6.100	.050	.123	0	.002	.080	.103
		12	2.60	.030	2.50	.100	1.71	.119	0	6.650	0	.128	0	.005	0	.052
	8-19-75	0	0.89	.044	2.25	.078	1.06	.021	0	0.485	0	.038	.060	.005	.010	.061
	3-16-77	0	0.96	.190	1.94	.134	1.36	.110	0	4.100	.100	.088	0	0	0	.094
		0	1.54	.214	2.21	.108	1.03	.040	0	3.100	.800	.106	.034	.003	0	.074
		2	0.71	.400	1.58	.112	1.36	.080	0	3.500	.100	.160	.017	.003	0	.059
		2	1.54	.236	2.08	.120	1.20	.080	0	2.800	.360	.122	.060	.007	0	.088
		4	1.30	.260	1.90	.122	1.20	.040	0	3.400	.440	.106	.034	0	0	.059
		4	1.30	.190	1.73	.128	1.52	.110	.468	3.000	.200	.122	0	0	0	0
		8	2.00	.120	1.74	.148	1.03	.080	0	3.200	.280	.142	0	0	.220	.068
		8	1.30	.236	2.06	.152	.071	.080	0	3.600	.200	.106	0	.008	0	.094

Appendix Table 15, cont'd.

Station	Date	Depth	Ca H_2O	Ca SM	Mg H_2O	Mg SM	K H_2O	K SM	Fe H_2O	Fe SM	Mn H_2O	Mn SM	Cu H_2O	Cu SM	Zn H_2O	Zn SM
								mg/l								
C	6-20-75	0	2.80	.015	1.30	.022	1.00	.010	0	0.475	0	.038	.020	.006	0	.048
		6	2.80	.025	1.25	.034	1.20	.018	0	1.800	0	.086	.020	.009	0	.062
		12	3.00	.010	1.46	.034	1.55	.028	0	8.250	1.110	2.400	0	.006	0	.058
	7- 1-75	0	2.10	0	1.30	.010	1.53	.015	.130	0.150	.150	.029	.020	.004	.030	.066
		8	2.00	0	1.32	.013	1.53	.027	.370	0.450	.290	.122	0	.014	0	.006
		16	1.95	.010	2.16	.020	2.15	.027	.045	3.900	2.900	.040	0	.017	.120	.024
	8- 5-75	0	2.80	.020	2.65	.025	1.71	.058	0	0.225	0	.023	0	.006	.180	.003
		1	2.40	.020	2.23	.025	2.00	.024	0	0.310	.070	.034	0	.002	.740	.024
		2	2.30	.030	2.02	.030	1.86	.024	0	0.283	.070	.025	0	.005	.200	.022
		4	2.30	.038	2.23	.040	1.71	.040	0	0.310	0	.036	0	.003	0	.078
		8	2.60	.020	2.45	.023	1.71	.024	0	0.800	0	.053	0	.002	0	.069
		16	2.70	.015	2.50	.038	1.86	.024	0	5.750	.300	.044	0	.006	.100	.037
	8-19-75	0	1.78	.067	3.00	.034	1.68	.021	0	0.065	.067	.013	.050	.018	0	.074
	3-16-77	0	0.95	.236	1.69	.080	1.20	.080	0	0.830	.280	.106	0	0	.220	.074
		0	1.54	.236	1.98	.086	0.71	.0	0	0.800	.200	.088	0	.003	.220	.207
		2	0.95	.120	1.98	.082	0.71	.040	0	0.670	.280	.088	0	.007	0	0
		2	1.18	.072	1.76	.100	0.88	.080	.200	0.890	.280	.142	0	.003	0	0
		4	1.30	.142	2.00	.086	0.88	.040	.133	0.890	.280	.142	0	0	0	0
		4	1.18	.166	1.66	.106	1.03	.040	.133	1.000	.280	.160	.017	.007	0	.044
		8	1.30	.166	2.04	.086	0.88	.040	0	0.730	.100	.088	0	0	0	0
		8	1.18	.096	1.83	.096	0.55	.040	0	0.930	.360	.106	.050	.003	0	0
		16	1.06	.096	2.14	.066	0.88	0	0	0.690	.530	.088	.017	0	0	0
		16	1.42	.120	2.02	.086	0.71	.040	0	0.840	.360	.142	.017	0	0	.048

Appendix Table 15, cont'd.

Station	Date	Depth	Ca H_2O	Ca SM	Mg H_2O	Mg SM	K H_2O	K SM	Fe H_2O	Fe SM	Mn H_2O	Mn SM	Cu H_2O	Cu SM	Zn H_2O	Zn SM
								mg/l								
D	11-11-74	0	1.65	.007	0.52	.014	1.68	.040	.100	.143	.030	.015	0	.004	.003	.000
		2	1.86	.014	0.47	.016	1.68	.068	.250	.143	.630	.031	0	.002	0	.000
		8	1.86	.040	0.45	.019	1.75	.040	.180	.113	0	.015	0	.004	0	.032
	3-12-75	0	1.11	.006	1.86	.026	0.82	.029	0	1.150	0	.000	0	.016	0	.023
		2	1.08	0	1.81	.020	0.82	.040	0	1.200	0	.017	0	.024	0	.026
	5-24-75	0	2.25	.060	45.00	.044	1.30	.015	0	.130	0	.022	0	.001	0	.180
		8	1.80	.014	29.00	.018	1.30	.010	0	.285	.080	.110	0	.001	0	.010
	5-26-75	0	2.30	.042	38.50	.055	1.30	.015	0	.190	0	.022	0	.003	0	.012
		8	1.78	.020	25.00	.024	1.30	.015	0	.290	.100	.000	0	.003	0	.013
		16	1.78	.014	14.00	.026	1.30	.015	0	1.600	.230	.134	0	.003	0	.013
		24	2.35	.010	36.50	.028	1.30	.015	1.550	4.500	5.000	.054	0	.003	0	.000
	6-20-75	0	2.80	.010	1.32	.021	1.20	0	0	.250	.020	.047	.020	.006	0	.000
		12	2.80	.020	1.32	.027	1.00	.018	1.700	3.400	.600	.171	.020	.006	0	.032
	7- 1-75	0	2.45	.010	1.33	.009	1.05	.015	0	.110	0	.094	0	.013	0	.016
		8	2.25	.020	1.35	.011	1.05	0	4.500	.190	0	.035	0	.004	.060	.032
		16	2.55	.020	1.51	.020	1.68	.027	0	2.000	.960	.029	.020	.006	0	.036
		24	2.80	.015	1.71	.021	1.68	.027	4.500	1.500	1.820	.035	0	.006	.120	.050
	8- 5-75	0	2.50	.030	2.70	.022	1.44	.024	0	.325	.030	.059	0	.003	0	0
		1	2.20	.025	1.88	.025	1.86	.040	0	.295	.050	.062	0	.005	.630	.037
		2	2.40	.025	2.42	.025	1.71	.024	0	.295	0	.056	0	.005	.220	.024
		4	2.70	.025	2.55	.020	1.44	.024	0	.295	0	.056	0	.750	0	1.850
		8	2.60	.020	2.55	.015	1.57	0	0	.268	0	.064	0	.002	.050	.042
		16	2.80	.015	2.82	.020	1.71	.024	2.300	2.900	1.350	.007	0	.003	.280	.030
		24	3.10	.020	3.13	.030	1.57	.040	2.900	2.100	2.360	.007	0	.007	.120	.054
	8-19-25	0	1.89	.055	3.15	.042	1.37	.021	.650	.138	.035	.026	0	.005	0	.067
	3-16-77	0	1.65	.260	2.52	.042	0.55	.040	.065	.360	.200	.088	.017	0	0	0
		0	1.52	.190	2.40	.034	0.55	.040	.030	.382	.100	.088	.050	.003	0	0
		2	1.54	.120	2.28	.045	1.03	.040	.065	.302	.200	.122	.067	0	0	0
		2	1.77	.096	2.36	.042	0.88	0	.133	.132	.200	.088	.034	0	0	0
		4	1.88	.120	2.50	.052	0.71	0	.165	.296	.360	.160	.050	0	0	.063
		4	1.54	.120	2.44	.059	0.71	.040	0	.372	.360	.106	.017	0	0	0
		8	1.65	.214	2.48	.035	1.03	.080	0	.202	.100	.122	.017	0	0	0
		8	1.30	.142	2.36	.038	0.71	.040	0	.224	.360	.072	0	0	0	0
		16	1.18	.142	2.55	.045	0.88	0	.065	.302	.290	.106	.017	0	0	0
		16	1.77	.236	2.31	.035	0.88	0	.100	.220	.200	.088	0	0	0	.044
		24	1.65	.142	2.52	.080	0.71	0	.065	.580	.100	.216	.034	0	0	.050
		24	1.77	.096	2.67	.112	1.03	.080	.030	1.400	.200	.200	.017	0	0	.078

Appendix Table 15, cont'd.

			Ca		Mg		K		Fe		Mn		Cu		Zn	
Station	Date	Depth	H_2O	SM	H_2O	SM	H_2O	SM	H_2O	SM	H_2O	SM	H_2O	SM	H_2O	SM
								mg/l								
E	3-16-77	0	1.54	.142	2.23	.052	0.88	0	0	.398	.440	.106	0	0	0	.059
		0	1.77	.142	2.32	.052	1.03	0	0	.338	.280	.072	.017	.007	0	.053
F	3-12-75	0	1.27	0	2.20	.024	0.67	.040	0	1.850	0	.021	0	.006	0	.036
		3	1.20	0	2.10	.020	0.82	.053	.060	1.300	0	.021	0	.010	0	.021
	11- 6-75	0	1.89	.022	0.96	.036	1.68	.021	0	.042	.035	.007	0	0	0	.016
	3-16-77	0	1.30	.120	1.10	.112	0.71	.040	.665	1.300	.530	.142	0	3.	0	.078
		0	1.42	.142	0.94	.118	0.55	.040	0	1.600	.100	.142	0	0	0	.044
		2	1.54	.142	1.26	.073	0.71	0	0	1.100	.280	.232	0	0	0	.078
		2	1.30	.142	1.15	.086	0.55	.040	0	.966	.360	.142	0	0	0	.053
		4	1.54	.236	1.22	.049	0.55	0	0	.880	0	.160	.050	0	0	0
		4	1.07	.096	0.96	.066	0.71	0	.100	.850	0	.122	.017	0	0	.068
G	8-19-75	0	1.89	.044	2.65	.028	1.68	.021	0	.065	.035	.007	.050	.006	.310	.007
	3-16-77	0	1.42	.096	2.14	.045	0.71	0	0	.422	.200	.106	.034	0	0	0
		0	1.77	.190	2.44	.055	0.55	0	0	.428	.360	.122	0	0	0	0
		2	1.65	.072	2.44	.055	0.55	0	0	.464	.200	.088	0	0	0	.064
		2	1.42	.120	2.44	.042	0.55	0	.030	.408	.280	.088	0	0	0	0
		4	1.88	.190	2.50	.017	0.71	0	.065	.388	.280	.106	.017	1.300	0	.069
		4	1.42	.096	2.50	.042	0.71	0	.100	.320	.360	.122	.034	0	0	.069

Appendix Table 16

Mean total carbon concentrations (mg/l) of West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	A	B	C	D	F	G	E
					mg/l			
1	0				4.52			
	2				6.11			
	8				5.17			
2	0		12.25	11.60	10.93			
	2		10.72	12.04	10.90			
3	0		11.15	8.81	9.08			
	4		16.78	11.81				
	8				9.73			
	12-16			12.78	7.51			
	24				5.83			
4	0	9.50	7.77	8.50	6.50	9.41	6.75	9.58
	2	7.78	7.49	10.61	8.72			
	4		7.63	9.25	6.77			
	8		7.92	8.36	10.75			
	16			12.26	9.10			
	24				9.66			
5	0	4.42	5.91	6.75	5.90	5.99	7.61	5.58
	2	5.02	6.14	5.61	5.19	6.56	6.43	
	4		6.32	4.89	5.69	5.42	6.42	
	8		9.83	4.99	5.80			
	12-16		4.83	6.62	4.90			
	24				9.59			

Appendix Table 17

Mean total organic carbon concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	A	B	C	D	F	G	E
					mg/l			
1	0				2.546			
	2				4.226			
	8				3.344			
2	0		10.004	9.203	8.865			
	2		8.444	9.585	8.805			
3	0		9.051	6.621	7.160			
	4		14.560	9.623				
	8				6.815			
	12-16			9.069	5.026			
	24				1.670			
4	0	7.350	5.716	6.266	4.228	7.072	4.501	6.426
	2	5.563	5.307	8.232	6.101			
	4		5.137	6.812	4.355			
	8		5.244	5.725	8.013			
	16			8.227	4.806			
	24				4.598			
5	0	2.443	3.723	4.413	3.801	3.682	4.822	3.066
	2	3.043	3.983	3.123	2.883	4.222	3.465	
	4		4.043	2.285	3.384	2.844	3.247	
	8		7.464	2.386	3.406			
	12-16		2.464	4.045	2.527			
	24				6.986			

Appendix Table 18

Mean particulate carbon concentrations in West Point Lake waters at indicated stations and depths for quarterly sampling periods between October 1, 1974 and December 31, 1975.

Period	Depth m	Station A	B	C	D	F	G	E
					mg/l			
1	0				0.370			
	2				0.710			
	8				0.680			
2	0		0.933	1.424	0.529			
	2		1.211	0.545	0.464			
3	0		0.135	1.473	1.126			
	4		6.621	0.308				
	8				1.928			
	12-16			4.696	0.911			
	24				2.116			
4	0	2.022	1.371	1.438	1.239	1.222	1.430	1.700
	2	2.080	1.200	1.365	0.920			
	4		1.692	1.780	0.863			
	8		1.788	0.970	0.720			
	16			3.347	2.568			
	24				2.811			
5	0	2.070	2.080	1.320	1.240	1.150	1.640	0.980
	2	4.480	2.500	1.430	0.890	1.290	1.290	
	4		1.790	2.410	0.810	1.370	1.240	
	8		2.230	1.440	1.390			
	12-16		2.290	2.110	1.370			
	24				2.680			

Appendix Table 19

Analysis of Variance Tables for

Conductivity at 0 - 2 m for Sta. A, B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	5	1,319.7775	15.50	0.0001
Depth	1	6.1020	0.07	0.7892
Sta. x depth	5	35.9778	0.42	0.8343
Period	6	6,378.1537	74.89	0.0001
Sta. x period	30	373.7153	4.39	0.0001
Depth x period	6	40.1909	0.47	0.8290
Sta. x depth x period	29	17.6118	0.21	1.0000
Error	273	85.1707		

Conductivity at 0 - 2 - 4 m for Sta. B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	4	1,932.6273	23.08	0.0001
Depth	2	16.3820	0.20	0.8224
Sta. x depth	8	40.2182	0.48	0.8700
Period	6	6,790.8586	81.10	0.0001
Sta. x period	24	332.8324	3.97	0.0001
Depth x period	12	35.5515	0.42	0.9535
Sta. x depth x period	48	20.3770	0.24	1.0000
Error	344	83.7326		

Conductivity at all depths for Sta. B, C, & D

Source	D.F.	M.S.	F value	PR > F
Sta.	2	617.9950	7.53	0.0006
Depth	4	360.3909	4.39	0.0018
Sta. x depth	8	42.4875	0.52	0.8429
Period	6	8,808.4444	107.39	0.0001
Sta. x period	12	519.8145	6.34	0.0001
Depth x period	24	92.6535	1.13	0.3078
Sta. x depth x period	48	34.7152	0.42	0.9998
Error	362	82.0237		

Appendix Table 20

Analysis of Variance Tables for

pH at 0 - 2 m for Sta. A, B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	5	3.8416	16.00	0.0001
Depth	1	0.5687	2.37	0.1249
Sta. x depth	5	0.1066	0.44	0.8191
Period	6	4.7414	19.75	0.0001
Sta. x period	30	1.3199	5.50	0.0001
Depth x period	6	0.0487	0.20	1.0000
Sta. x depth x period	29	0.0487	0.20	1.0000
Error	275	0.2400		

pH at 0 - 2 - 4 m for Sta. B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	4	1.8822	8.77	0.0001
Depth	2	4.2792	19.94	0.0001
Sta. x depth	8	0.3021	1.41	0.1918
Period	6	3.9307	18.32	0.0001
Sta. x period	24	1.0780	5.02	0.0001
Depth x period	12	0.8702	4.06	0.0001
Sta. x depth x period	48	0.2744	1.28	0.1118
Error	346	0.2146		

pH at all depths for Sta. B, C, & D

Source	D.F.	M.S.	F value	PR > F
Sta.	2	1.3891	9.80	0.0001
Depth	4	5.9371	41.88	0.0001
Sta. x depth	8	0.2854	2.01	0.0440
Period	6	1.5665	11.05	0.0001
Sta. x period	12	0.9930	7.00	0.0001
Depth x period	24	0.3646	5.65	0.0001
Sta. x depth x period	48	0.3646	2.57	0.0001
Error	362	0.1418		

Appendix Table 21

Analysis of Variance Tables for

CO_2 at 0 - 2 m for Sta. A, B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	5	10.9941	16.24	0.0001
Depth	1	1.0263	1.52	0.2192
Sta. x depth	5	0.1269	0.19	0.9652
Period	6	9.8722	14.59	0.0001
Sta. x period	30	2.4414	3.61	0.0001
Depth x period	6	0.3438	0.51	0.8022
Sta. x depth x period	29	0.3765	0.56	0.9701
Error	275	0.6768		

CO_2 at 0 - 2 - 4 m for Sta. B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	4	6.9359	20.16	0.0001
Depth	2	8.2935	24.10	0.0001
Sta. x depth	8	0.6427	1.87	0.0641
Period	6	7.0223	20.41	0.0001
Sta. x period	24	1.4527	4.22	0.0001
Depth x period	12	1.2367	3.59	0.0001
Sta. x depth x period	48	0.4140	1.20	0.1782
Error	346	0.3441		

CO_2 at all depths for Sta. B, C, & D

Source	D.F.	M.S.	F value	PR > F
Sta.	2	4.3220	3.62	0.0277
Depth	4	121.7273	101.97	0.0001
Sta. x depth	8	10.9213	9.15	0.0001
Period	6	22.1036	18.52	0.0001
Sta. x period	12	8.1330	6.81	0.0001
Depth x period	24	17.6263	14.77	0.0001
Sta. x depth x period	48	2.8639	2.40	0.0001
Error	362	1.1938		

Appendix Table 22

Analysis of Variance Tables for

Total inorganic N at 0 - 2 m for Sta. A, B, C, D, F, & G

Source	D.F.	M.S.	F value	PR> F
Sta.	5	3.6953	47.31	0.0001
Depth	1	0.1639	2.10	0.1486
Sta. x depth	5	0.0301	0.38	0.8599
Period	6	4.9617	63.52	0.0001
Sta. x period	30	0.2468	3.16	0.0001
Depth x period	6	0.0139	0.18	0.9827
Sta. x depth x period	29	0.0236	0.30	0.9998
Error	275	0.0781		

Total inorganic N at 0 - 2 - 4 m for Sta. B, C, D, F, & G

Source	D.F.	M.S.	F value	PR> F
Sta.	4	3.1602	42.49	0.0001
Depth	2	0.3276	4.40	0.0129
Sta. x depth	8	0.0698	0.94	0.4849
Period	6	4.9798	66.96	0.0001
Sta. x period	24	0.2894	3.89	0.0001
Depth x period	12	0.0404	0.54	0.8858
Sta. x depth x period	48	0.0371	0.50	0.9979
Error	346	0.0744		

Total inorganic N at all depths for Sta. B, C, & D

Source	D.F.	M.S.	F value	PR> F
Sta.	2	2.9689	34.91	0.0001
Depth	4	2.0661	24.30	0.0001
Sta. x depth	8	0.1841	2.17	0.0295
Period	6	4.9493	58.20	0.0001
Sta. x period	12	0.4467	5.25	0.0001
Depth x period	24	0.2243	2.64	0.0001
Sta. x depth x period	48	0.1207	1.42	0.0411
Error	362	0.0850		

Appendix Table 23

Analysis of Variance Tables for

Ortho P at 0 - 2 m for Sta. A, B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	5	0.1507	43.09	0.0001
Depth	1	0.0003	0.09	0.7687
Sta. x depth	5	0.0010	0.28	0.9213
Period	6	0.0520	14.86	0.0001
Sta. x period	30	0.0091	1.61	0.0001
Depth x period	6	0.0015	0.42	0.8667
Sta. x depth x period	29	0.0007	0.21	1.0000
Error	275	0.0035		

Ortho P at 0 - 2 - 4 m for Sta. B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	4	0.0339	23.77	0.0001
Depth	2	0.0007	0.53	0.5874
Sta. x depth	8	0.0014	0.97	0.4627
Period	6	0.0514	36.11	0.0001
Sta. x period	24	0.0058	4.08	0.0001
Depth x period	12	0.0008	0.56	0.8711
Sta. x depth x period	48	0.0006	0.45	0.9995
Error	346	0.0014		

Ortho P at all depths for Sta. B, C, & D

Source	D.F.	M.S.	F value	PR > F
Sta.	2	0.0623	37.29	0.0001
Depth	4	0.0050	2.98	0.0191
Sta. x depth	8	0.0019	1.11	0.3525
Period	6	0.0560	33.54	0.0001
Sta. x period	12	0.0095	5.71	0.0001
Depth x period	24	0.0036	2.13	0.0018
Sta. x depth x period	48	0.0018	1.10	0.3108
Error	362	0.0017		

Appendix Table 24

Analysis of Variance Tables for

Particulate P at 0 - 2 m for Sta. A, B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	5	0.0168	12.93	0.0001
Depth	1	0.0025	1.93	0.1656
Sta. x depth	5	0.0003	0.21	0.9548
Period	6	0.4534	349.29	0.0001
Sta. x period	30	0.0038	2.96	0.0001
Depth x period	6	0.0026	1.96	0.0672
Sta. x depth x period	29	0.0003	0.20	1.0000
Error	275	0.0013		

Particulate P at 0 - 2 - 4 m for Sta. B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	4	0.0108	7.53	0.0001
Depth	2	0.0019	1.35	0.2601
Sta. x depth	8	0.0003	0.19	0.9924
Period	6	0.5770	403.40	0.0001
Sta. x period	24	0.0054	3.76	0.0001
Depth x period	12	0.0022	1.53	0.1097
Sta. x depth x period	48	0.0004	0.26	1.0000
Error	346			

Particulate P at all depths for Sta. B, C, & D

Source	D.F.	M.S.	F value	PR > F
Sta.	2	0.0226	14.90	0.0001
Depth	4	0.0059	3.87	0.0043
Sta. x depth	8	0.0010	0.63	0.7565
Period	6	0.5751	379.18	0.0001
Sta. x period	12	0.0075	4.95	0.0001
Depth x period	24	0.0029	1.93	0.0058
Sta. x depth x period	48	0.0009	0.59	0.9873
Error	362	0.0015		

Appendix Table 25

Analysis of Variance Tables for

Total alkalinity at 0 - 2 m for Sta. A, B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	5	66.4680	19.30	0.0001
Depth	1	0.7856	0.23	0.6335
Sta. x depth	5	0.1997	0.06	0.9965
Period	6	171.5158	49.81	0.0001
Sta. x period	30	11.6020	3.37	0.0001
Depth x period	6	0.3739	0.11	0.9954
Sta. x depth x period	29	0.2923	0.08	1.0000
Error	275	3.4434		

Total alkalinity at 0 - 2 - 4 m for Sta. B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	4	88.3357	28.92	0.0001
Depth	2	3.6555	1.20	0.3034
Sta. x depth	8	1.1097	0.36	0.9393
Period	6	229.5051	75.14	0.0001
Sta. x period	24	17.5012	5.73	0.0001
Depth x period	12	1.8861	0.62	0.8274
Sta. x depth x period	48	0.9798	0.32	1.0000
Error	346	3.0544		

Total alkalinity at all depths for Sta. B, C, & D

Source	D.F.	M.S.	F value	PR > F
Sta.	2	52.7534	6.09	0.0025
Depth	4	210.5365	24.29	0.0001
Sta. x depth	8	11.3462	1.31	0.2374
Period	6	286.1160	33.01	0.0001
Sta. x period	12	81.2686	9.38	0.0001
Depth x period	24	33.6694	3.89	0.0001
Sta. x depth x period	48	12.9276	1.49	0.0234
Error	362	8.6663		

Appendix Table 26

Analysis of Variance Tables for

Turbidity (JTU) at 0 - 2 m for Sta. A, B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	5	9,665.9184	48.11	0.0001
Depth	1	124.7410	0.62	0.4314
Sta. x depth	5	60.0040	0.30	0.9129
Period	6	17,692.1729	88.05	0.0001
Sta. x period	30	1,446.7908	7.20	0.0001
Depth x period	6	103.2880	0.51	0.7976
Sta. x depth x period	29	43.5101	0.22	1.0000
Error	275	200.9309		

Turbidity (JTU) at 0 - 2 - 4 m for Sta. B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	4	8,238.2388	56.98	0.0001
Depth	2	84.4581	0.58	0.5581
Sta. x depth	8	45.3695	0.31	0.9606
Period	6	24,764.7218	171.29	0.0001
Sta. x period	24	2,400.1912	16.60	0.0001
Depth x period	12	100.9779	0.70	0.7531
Sta. x depth x period	48	30.9798	0.21	1.0000
Error	346	144.5751		

Turbidity (JTU) at all depths for Sta. B, C, & D

Source	D.F.	M.S.	F value	PR > F
Sta.	2	20,433.1374	108.06	0.0001
Depth	4	703.6727	3.72	0.0055
Sta. x depth	8	188.7667	1.00	0.4369
Period	6	29,042.2193	153.59	0.0001
Sta. x period	12	6,061.9732	32.06	0.0001
Depth x period	24	439.6550	2.33	0.0005
Sta. x depth x period	48	62.4054	0.33	1.0000
Error	362	189.0833		

Appendix Table 27

Analysis of Variance Tables for

TOC at 0 - 2 m for Sta. A, B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	4	7.0401	5.87	0.0001
Depth	2	2.7069	2.26	0.1063
Sta. x depth	8	0.4538	0.38	0.9318
Period	6	15.6997	13.09	0.0001
Sta. x period	24	4.2567	3.55	0.0001
Depth x period	12	1.0860	0.91	0.5416
Sta. x depth x period	48	1.2100	1.01	0.4621
Error	328	1.1992		

TOC at 0 - 2 - 4 m for Sta. B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	5	3.1888	2.69	0.0215
Depth	1	7.9105	6.68	0.0103
Sta. x depth	5	2.3791	2.01	0.0770
Period	6	11.5184	9.72	0.0001
Sta. x period	30	3.5030	2.96	0.0001
Depth x period	6	0.9474	0.80	0.5708
Sta. x depth x period	29	0.9447	0.80	0.7636
Error	263	1.1845		

TOC at all depths for Sta. B, C, & D

Source	D.F.	M.S.	F value	PR > F
Sta.	2	8.6433	5.45	0.0046
Depth	4	1.3405	0.85	0.4968
Sta. x depth	8	1.1593	0.73	0.6636
Period	6	39.5525	24.96	0.0001
Sta. x period	12	8.5015	5.37	0.0001
Depth x period	24	2.5957	1.64	0.0315
Sta. x depth x period	48	1.6993	1.07	0.3526
Error	349	1.5845		

Appendix Table 28

Analysis of Variance Tables for

Particulate C at 0 - 2 m for Sta. A, B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	4	1.9951	3.59	0.0069
Depth	2	1.1096	2.00	0.1373
Sta. x depth	8	0.3441	0.62	0.7616
Period	6	3.4253	6.17	0.0001
Sta. x period	24	1.3585	2.45	0.0002
Depth x period	12	0.3290	0.59	0.8484
Sta. x depth x period	48	0.2979	0.54	0.9951
Error	340	0.5555		

Particulate C at 0 - 2 - 4 m for Sta. B, C, D, F & G

Source	D.F.	M.S.	F value	PR > F
Sta.	5	21.4254	15.42	0.0001
Depth	1	0.2340	0.17	0.6819
Sta. x depth	5	0.5005	0.36	0.8759
Period	6	4.4160	3.18	0.0050
Sta. x period	30	2.0586	1.48	0.0560
Depth x period	6	0.3124	0.22	0.9685
Sta. x depth x period	29	0.3244	0.23	1.0000
Error	269	1.3898		

Particulate C at all depths for Sta. B, C, & D

Source	D.F.	M.S.	F value	PR > F
Sta.	2	3.4786	5.26	0.0056
Depth	4	3.5246	5.33	0.0004
Sta. x depth	8	0.8616	1.30	0.2407
Period	6	6.7408	10.19	0.0001
Sta. x period	12	2.0265	3.06	0.0004
Depth x period	24	1.0339	1.56	0.0462
Sta. x depth x period	48	0.6909	1.04	0.3983
Error	355	0.6613		

Appendix Table 29

Analysis of Variance Tables for

Filtrable Suspended Matter at 0 - 2 m for Sta. A, B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	4	2,795.6651	66.51	0.0001
Depth	2	37.2644	0.89	0.4130
Sta. x depth	8	135.3057	3.22	0.0015
Period	6	7,733.2830	183.99	0.0001
Sta. x period	24	885.0914	21.06	0.0001
Depth x period	12	23.8890	0.57	0.8672
Sta. x depth x period	48	50.3373	1.20	0.1851
Error	328	42.0319		

Filtrable Suspended Matter at 0 - 2 - 4 m for Sta. B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	5	11,471.4785	93.40	0.0001
Depth	1	9.8394	0.08	0.7774
Sta. x depth	5	113.7738	0.93	0.4654
Period	6	6,714.1644	54.67	0.0001
Sta. x period	30	1,305.1158	10.63	0.0001
Depth x period	6	23.1177	0.19	0.9800
Sta. x depth x period	29	58.3502	0.48	0.9907
Error	265	122.8147		

Filtrable Suspended Matter at all depths for Sta. B, C, & D

Source	D.F.	M.S.	F value	PR > F
Sta.	2	6,145.9432	80.28	0.0001
Depth	4	490.8053	6.41	0.0001
Sta. x depth	8	247.9336	3.24	0.0014
Period	6	8,914.3434	116.44	0.0001
Sta. x period	12	2,114.8787	27.63	0.0001
Depth x period	24	98.9269	1.29	0.1645
Sta. x depth x period	48	67.9239	0.89	0.6862
Error	350	76.5563		

Appendix Table 30

Analysis of Variance Tables for

Organic Matter at 0 - 2 m for Sta. A, B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	4	78.6628	19.47	0.0001
Depth	2	0.7479	0.19	0.8312
Sta. x depth	8	1.1133	0.28	0.9734
Period	5	16.6806	4.13	0.0014
Sta. x period	20	4.2086	1.04	0.4148
Sta. x depth x period	40	1.2765	0.32	1.0000
Error	223	4.0412		

Organic Matter at 0 - 2 - 4 m for Sta. B, C, D, F, & G

Source	D.F.	M.S.	F value	PR > F
Sta.	5	592.0832	48.14	0.0001
Depth	1	0.2422	0.02	0.8885
Sta. x depth	5	3.0313	0.25	0.9399
Period	5	25.1408	2.04	0.0740
Sta. x period	25	35.8046	2.91	0.0001
Depth x period	5	1.3228	0.11	0.9885
Sta. x depth x period	25	2.7985	0.23	1.0000
Error	175	12.2990		

Organic Matter at all depths for Sta. B, C, & D

Source	D.F.	M.S.	F value	PR > F
Sta.	2	186.7677	22.34	0.0001
Depth	4	71.5345	8.56	0.0001
Sta. x depth	8	9.3797	1.12	0.3493
Period	5	9.1033	1.09	0.3674
Sta. x period	10	1.8825	0.23	0.9937
Depth x period	20	14.9801	1.79	0.0225
Sta. x depth x period	38	2.8304	0.34	1.0000
Error	228	8.3605		

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